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Education Department Bulletin

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No. 475 ALBANY, N. Y. JULY 15, 1910

New York State Museum

JOHN M. CLARKE, Director
EPHRAIM PORTER FELT, State Entomologist

Museum Bulletin 141

25th REPORT OF THE STATE ENTOMOLOGIST

ON

INJURIOUS AND OTHER INSECTS

OF THE

STATE OF NEW YORK

1909

ALBANY
UNIVERSITY OF THE STATE OF NEW YORK
1910

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New York State Education Department
Science Division, February 23, 1910

Hon. Andrew S. Draper LL.D.
Commissioner of Education

SIR: I have the honor to communicate herewith for publication as a bulletin of the State Museum, the report of the State Entomologist for the fiscal year ending September 30, 1909.

Very respectfully
JOHN M. CLARKE
Director

State of New York
Education Department
COMMISSIONER'S ROOM

Approved for publication this 24th day of February 1910

A. S. Draper

Commissioner of Education

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New York State Museum

John M. Clarke, Director
Ephraim Porter Felt, State Entomologist

Museum Bulletin 141

25th REPORT OF THE STATE ENTOMOLOGIST 1909

To John M. Clarke, Director of Science Division

I have the honor of presenting herewith my report on the injurious and other insects of the State of New York for the year ending October 15, 1909.

The horticultural world was startled early the present year by the discovery of thousands of young brown tail moth caterpillars in their winter nests on many shipments of nursery stock imported from France. Drastic recommendations were made and promptly adopted by the Commissioner of Agriculture with the result that, so far as known, none of the pests succeeded in establishing themselves. The middle of June was noteworthy on account of the finding of a small colony of nearly full grown caterpillars of this species at Port Chester, N. Y. The thoroughgoing measures adopted in this instance appear to have resulted in extermination.

Fruit tree pests. The most conspicuous injury to fruit the past season was undoubtedly caused by the hordes of plant lice which not only abounded upon apple but were exceedingly numerous on cherry and more or less destructive to plum. The attack on the apple was followed by the trees producing large numbers of small, gnarly fruit, the latter forming 35 to 45 per cent of the total number of fruit in some orchards. The exact records of the injury in the two experimental orchards will be found on a subsequent page. One apple grower estimated the loss at 50 per cent. This phenomenal outbreak coincided with unusually cool weather and was undoubtedly greatly favored by climatic conditions. The cigar case bearer was somewhat abundant in orchards in the west-

ern part of the State, though it was not so numerous as in 1908. The blister mite continued its injuries of last season and in some localities was much more prevalent, this being particularly true of the Hudson valley.

The San José scale continues to be one of the important pests of the horticulturist though progressive fruit growers have little difficulty in controlling it. The general experience with lime-sulfur washes has been exceedingly satisfactory. A number of the commercial preparations of this material have given excellent results. Fruit growers are now beginning to use this wash in a more diluted form as a summer spray for plant lice and fungous diseases.

Codling moth. The codling moth is one of the most important enemies of the fruit grower. A series of practical experiments were carried through the season for the purpose of ascertaining the actual benefit resulting from the application of arsenical poisons, and also the relative efficacy of insecticides applied with a coarse or a fine spray. These experiments were conducted in the orchard of Mr W. H. Hart of Poughkeepsie and that of Mr Edward VanAlstyne at Kinderhook, N. Y. Great pains were taken at the outset to secure an infested orchard with an ample number of trees likely to bear a nearly uniform amount of fruit. Each plot consisted of 42 trees, the fruit from the central six alone being counted. The others were used as barriers to prevent the treatment of one plot reacting upon the trees in another. These experiments involved considerable labor, since three sprayings were given in the case of the orchard at Poughkeepsie. It was furthermore necessary to sort and classify over 100,000 apples in this orchard alone. A reference to the data on a following page shows a most striking difference between the fruit from the sprayed and the unsprayed trees and indicates in no uncertain manner the supreme importance of thorough work.

Small fruits. The unusually severe injury by the grape blossom midge noted in 1908, was continued the past season though the insect may not have been quite so prevalent throughout the grape belt. The acre of early Moore grapes recorded as seriously injured last year was badly damaged the past season. We were fortunate enough in early spring to rear the adult, a fragile midge which has hitherto escaped notice although the blighted blossom buds have been common for several years. Owing to the delay in issuing the report for 1908 it was possible to give, in that publication, a full account of the pest.

The grape root worm, though generally prevalent in the Chautauqua region, has not caused much alarm. This is due in part to a more thorough understanding of the insect and methods of controlling it, and also to better cultivation and fertilization. The latter are important factors in producing vines capable of withstanding injury.

Shade tree pests. The protection of our shade trees from the ravages of insect pests has continued, as it most assuredly should, to receive much attention. It is gratifying to record that the general public is displaying a most commendable interest in this phase of economic entomology. There have been numerous demands for information in regard to these pests and methods of controlling them. The supplying of such has been an important part of the office work.

The elm leaf beetle has been somewhat prevalent in the Hudson and Mohawk valleys. It caused extensive injury for the first time in the city of Amsterdam and was quite destructive at Schenectady and also at Sandy Hill. There was general though not very severe injury in both Albany and Troy, while judging from reports this pest has been exceedingly destructive to elms on Long Island.

The spruce gall aphid, noticed in the preceding report, has continued abundant and rather injurious in widely separated portions of the State. It is a species which should be watched closely, since it is capable of causing severe damage, by destroying the terminal twigs and thus stunting the growth.

The sugar maple borer continues to be a serious enemy of maples. It was particularly abundant the past summer at Fulton, N. Y. A number of trees in that village were badly affected and a few were dying as a result of the recent work of this pernicious borer.

Forest insects. The ravages of forest insects are increasing in severity with the lapse of time. Our forest trees have suffered greatly in recent years from outbreaks by leaf-feeding caterpillars. The snow-white linden moth has been one of the chief offenders. The past season was marked by extensive depredations by this pest. The flight of hosts of white moths about city and village lights, so generally noticed in 1908 was observed the past season.

The small, modest, grayish and olive-brown moths of the spruce bud worm attracted unusual notice in midsummer on account of their prevalence at street lights in a number of widely separated cities. These flights, judging from reports received, have been preceded by serious injuries to spruce trees in the Adirondacks.

The hickory bark borer, a most pernicious enemy of hickories, has been very injurious to the magnificent trees of Prospect Park, Brooklyn. Injuries by this pest have also been reported from the central portion of the State. This nefarious pest has in recent years destroyed thousands of valuable trees in this State. Its destructive potentialities amply justify the prompt destruction of infested trees.

Gipsy and brown tail moths. The appearance of the latter species in this State has already been mentioned and must be regarded as but the precursor of similar visitations. This insect has not, to our knowledge, become established west of the Connecticut valley, and it is to be hoped that the repressive measures, prosecuted jointly by the state of Massachusetts and the federal government, will result in keeping this destructive form at a distance for some years to come.

The finding of numerous winter nests of the brown tail moth upon imported French stock last winter resulted in our conducting a series of experiments for the purpose of determining the efficiency of hydrocyanic acid gas as an agent in the destruction of the caterpillars. Though this most deadly gas has given excellent results with other species, it proved of no service in killing brown tail moth caterpillars within their nests, and could not be relied upon to destroy free caterpillars in a dormant condition at any reasonable strength and without an unduly prolonged exposure. The details of these experiments, showing the unreliability of this gas, are given on a following page. On the other hand, dipping the caterpillars in a miscible oil was invariably followed by death.

There is still no authentic record of the gipsy moth having become established in New York State. The pest has not made its way nearer than the outlying small colonies known to exist at Springfield and Greenfield, Mass. and the more recent infestation at Wallingford, Conn. The Entomologist has sent out a number of warning placards to places where these insects would be most likely to become established and as yet nothing suspicious has been discovered.

Miscellaneous. The large, olive-colored form known as Say's blister beetle was unusually abundant in the vicinity of Albany and occasioned some anxiety lest it prove a serious pest. There was a restricted outbreak of the army worm at Oakdale. Conditions were evidently rather favorable for more extended mischief by this insect, since the writer found the caterpillars numerous at Port

Chester though not very evident on account of the large amount of provender upon which they could subsist.

House fly. This insect, with its acknowledged potentiality for evil, is one of the most important of our injurious species. The present great interest in the house fly and methods for its control led to the devising of a vivarium or special house for the purpose of testing the behavior of this insect in relation to light and in particular to ascertain whether darkness or partial darkness could not be used as a barrier to keep this ubiquitous form from breeding materials of various kinds. The house was a light-proof structure with partitions arranged in about the same way as those in the photographer's dark room, and flies were given a free opportunity to enter as far as they would with a constantly decreasing illumination and deposit eggs upon moist horse manure. The details of the experiments, given on a following page, show that this insect will not invade moderately dark places for the purpose of depositing its eggs. It should be comparatively easy and very practical to store all such materials in dark or nearly dark places.

Gall midges. The work upon this group has been pushed as rapidly as possible consistent with the discharge of other duties. We have been able to make material additions to our knowledge of the biology of this group. This was particularly marked in the case of Sackenomyia, originally described from a female taken on the wing and now represented in addition by two reared species, of which both sexes, larvae and galls are known. The life histories of a number of species of Caryomyia, forms responsible for the peculiar and varied hickory leaf midge galls, have been worked out. Likewise, a number of species of Cincticornia, a genus confined to oak, have been reared and some exceedingly gratifying data obtained. This by no means exhausts possibilities with this group, since material has come in so rapidly in recent months that it has been practically impossible to classify it adequately and at the same time collect or rear additional forms. Over 50 species have been reared during the year, most of them new and making a total in the collections of probably over 800 species, about 350 having been reared. This large number of specimens, in some instances species are represented by a hundred midges, is practically classified and requires only a relatively small amount of descriptive and collative work before being made available to the public.

Special acknowledgments in this connection are due Miss Cora H. Clarke of Boston, Mass. who has collected and forwarded to

us large series of galls from which we were able to rear a number of previously unknown species. The care of this material devolved largely upon Assistant D. B. Young, who has met with exceptional success in rearing the flies. Miss Fanny T. Hartman has assisted in caring for the biological material and has made excellent microscopical mounts of many of these extremely delicate midges.

Publications. Many brief, popular accounts dealing with injurious insects have been prepared by the Entomologist for the agricultural and local press and a few notices of more than general interest have been disseminated as press bulletins or through the agency of the Associated Press. A comprehensive popular bulletin on the *Control of Household Insects,* made advisable by the recent great advances in our knowledge of the relation of insects to the dissemination of disease, was issued in May and is now, due to the great demand for such information, practically out of print. The report for last year, owing to delays incident to publication, was not issued till the last of the present year. A popular account summarizing one phase of our studies of gall midges and entitled: "Gall Midges of the Goldenrod," appeared in the *Ottawa Naturalist* for February. Biological data and brief descriptions of nearly 50 reared species of Cecidomyiidae were published in the issue of the *Journal of Economic Entomology* for August.

Collections. The additions to the collections have not been very extensive, since the amount of material already at hand demands the expenditure of much time before it can be properly classified. Particularly gratifying additions have been made by rearing large series of Caryomyia, Cincticornia and Sackenomyia, the biology of these genera being previously unknown. There have been valuable contributions of biological material, mostly insect galls, through the generosity of Miss Cora H. Clarke of Boston, Mass.

The general work on the arrangement and classification of the collection has been pushed as rapidly as possible. Mr D. B. Young has identfied practically all our species of Bombylidae, has done considerable work upon the Empididae and made substantial progress in classifying the Sapromyzidae, the Tabanidae and the Sciomyzidae. Mr Young is also responsible in large measure for the preparation of the list of insect types in the New York State collection given on a following page. Much of Miss Hartman's time has been devoted to the care of breeding material, to mounting and

labeling, to interpolating specimens, particularly Microlepidoptera in the general collections, and to bibliographic work.

Several greatly enlarged models representing injurious insects or portions of such forms have added very much to the educational value of the entomologic exhibit. A list of these models is given on a succeeding page. This is only the beginning of what should be done along this line, since if one may judge from the work of other museums, the practical value of the exhibit collections has been greatly enhanced by accurate and tastefully executed models of important species. It is to be hoped that provision can be made shortly for the continuance of this work along comprehensive lines.

Office matters. The general work of the office has progressed smoothly, the Assistant State Entomologist being responsible for correspondence and other matters during the absence of the Entomologist. Both Mr Young and Miss Hartman devoted much time to the experiments with larvae of the brown tail moth noted on another page. Numerous specimens have been received for identification and many inquiries made concerning injurious forms. 1851 letters, 614 postals, 208 circulars, 2597 packages were sent through the mails and 83 packages were shipped by express.

Nursery certificates. On the request of the State Commissioner of Agriculture, as in previous years, nursery certificates issued by his office and destined to points in the state of Virginia, were indorsed by the Entomologist. The following is a list of the firms to whom these nursery certificates were issued during the past year: Greens Nursery Co. and the Pan-American Nurseries, both of Rochester; Jacob Uhl, Maloney Bros. & Wells, Sherrins Wholesale Nurseries, all of Dansville and F. E. Schifferli of Fredonia.

General. As in past years, the work of this office has been greatly facilitated by identifications of certain species through the courtesy of Dr L. O. Howard, Chief of the Bureau of Entomology, United States Department of Agriculture and his associates. Several correspondents have been of material service in securing valuable specimens of one kind or another and as heretofore there has been a most helpful cooperation on the part of all interested in the work of this office.

Respectfully submitted

EPHRAIM PORTER FELT

State Entomologist

Office of the State Entomologist, October 15, 1909

INJURIOUS INSECTS

Typhoid or house fly

Musca domestica Linn.

An attempt was made the past season to obtain accurate data respecting this insect's behavior toward light. The principal object of the experiment was to determine the possibility of storing manure and other substances in which this pest breeds, in dark or nearly dark cellars or compartments.

Outline of conditions. A fly vivarium [pl. 1] was located in the writer's back yard (a typical village lot) at Nassau, Rensselaer co., N. Y. This building was a nearly light-proof structure 6 feet by 10 feet in outside dimensions and with a hight of 6 feet 4 inches in front and 5 feet 6 inches in the back. To facilitate the location of materials etc., the spaces between the joists were numbered consecutively, beginning at the door on the north wall and running around and including in the enumeration the spaces of the partitions as well as the outside wall [*see* pl. 2]. A light-proof window (18 x 18 in.) was made in the south wall near the southwest corner (at station 16) and another in the west wall (at station 13). Light-proof partitions, arranged somewhat like those in a photographer's dark room divided the interior [*see* pl. 2] in such a manner that there was a constant decrease in the light as one progressed from the door back through the partitions and around to the darkest corner near the middle of the south end, station 12. Ventilators were provided in the roof at A and B [*see* pl. 2]. There is in the southeast corner at station 23, a small closet 21 inches deep and 3 feet above the ground. The interior of the building was painted a dull black the latter part of April. The door located at the northwest corner is 26½ inches wide and 71¼ inches high. This door was allowed to remain open throughout the season and the entrance of animals or children prevented by the use of a coarsely screened (½ inch mesh) door having an interior clear space of 23 by 67 inches. The building was so situated that August 24 at 8 a. m. rays of the sun reached back to the base of the corner of station 8 and a little later in the day would extend to the base of the pail at station 6. There was sufficient illumination under these conditions at station 18 so that one experienced little difficulty in discerning objects located there. Mackerel kits containing horse manure thoroughly sterilized by steam were located at stations 6, 12, 18 and 23. In addition, sheets of a dull black paper, specially treated through the courtesy of the O. & W. Thum

Co. of Grand Rapids, Mich., with the preparation so familiar on tanglefoot fly paper, were tacked up at stations 2, 4, 6, 12, 14, 18 and 22 about 5 feet from the ground. The vivarium was located about 20 feet from one barn where a horse was kept, the manure from the animal being thrown outdoors. There was another barn where at least two animals were kept throughout the summer about 40 feet away to the southwest and another barn about 50 feet due east. This latter had been occupied in previous years by six to eight horses, and when the vivarium was constructed it was expected that an equal number of animals would be kept in the building throughout the summer. Owing to a change of plans but one horse was kept in this barn, and as a partial result of this change there have been considerably fewer flies than in previous years. Furthermore, the excessively cool weather continuing well into June greatly delayed the appearance of the house fly in numbers. Relatively cool weather continuing throughout the summer has also served to prevent rapid breeding. This combination of causes has resulted in house flies being much scarcer than usual.

Experiments. House flies were becoming somewhat abundant June 23d and operations were commenced by placing mackerel kits nearly filled with sterilized horse manure at stations [*see* numbers on plate] 6, 12, 18 and 23. At the latter station there was a second mackerel kit or check pail containing ordinary horse manure. Practically no flies were observed about the vivarium June 23d and the same was true the morning of the 24th. An examination Saturday afternoon the 26th gave negative results, since there were no evidences of flies in the house, aside from a possible specimen or two just within the screen door. On the afternoon of June 29 a fly was seen at station 22 and several at station 6. There were no signs of house flies at stations 8, 18 or 12. July 17, 5 or 6 house flies were seen about the door. August 3 they were rather numerous in and about the vivarium. On this date a second pail of sterilized horse manure was placed at each of the stations just mentioned and in addition, a pail about ⅔ full of miscellaneous swill covered with 2 inches of horse manure was set just outside the door in the hopes of attracting more flies. The records will now be given by stations, beginning with the pail outdoors.

Pail outdoors containing swill and manure. August 23 this pail was found to be filled by recent rains and contained several Muscid larvae. September 11th this pail, though well shaded by squash vine leaves, contained 12 large dipterous larvae, probably *Musca domestica* and a rat-tail syrphid larva, probably *Eristalis tenax* Linn. We were unable to rear these larvae to maturity.

Station 23. June 29 numerous Borborids, Limosina sp., were observed in the mackerel kit containing untreated horse manure, undoubtedly issuing from this and spreading from the check to the adjacent sterilized manure. July 23d the surface of the manure was rather dry and both pails were in nearly the same mechanical condition. The manure was watered July 10th and the 13th, only a few flies being observed on these dates. July 17 the conditions at station 23 were nearly the same as at station 6 though small flies were not so numerous and on the 21st flies were much less abundant than at station 6. August 23 this pail contained numerous small flies and larvae though none of Musca domestica. The manure was well rotted and wet. The check pail was practically in the same condition. September 11 there were numerous Sciaras on the surface of the manure and a few small Cecidomyiid larvae; the manure was quite wet, rather well rotted and the pail only about half full. The check was in nearly the same condition. September 26 Psychodids were rather numerous.

The new pail contained young mushrooms August 23 and there were a few small flies on the surface of the manure. September 11 there were several Muscid larvae, some Sciara larvae and a few small Cecidomyiid larvae in the manure. Sciara adults were numerous. The pail contents were nearly saturated and but slightly rotted. September 27 Psychoda alternata adults were rather abundant.

Station 6. One house fly was observed on the manure June 29 and several nearly full grown maggots were found some 4 inches below the surface July 8. The contents of the pail were wet July 10th and 13th and numerous small flies and 5 or 6 house flies were observed on or about the manure on July 17th, shortly after some swill consisting of orange peelings, vegetable parings, biscuit etc. had been placed near by. July 21 numerous specimens of Drosophila ampelophila were seen flying in the vicinity of the manure, alighting upon the swill, crawling upon adjacent walls and hovering in the upper section of this part of the house. They also spread somewhat to station 8 but none were observed in the vicinity of stations 18 and 12. These insects were undoubtedly attracted in large measure by the swill, since they were much less numerous at station 23 though somewhat abundant. August 3 house flies were entering freely, going back to station 6 and spreading a little on one side to station 8. The manure was inhabited by many

small dipterous larvae, probably Drosophila; the contents of the pail were quite moist. August 23 there were a number of small flies and other larvae. There were numerous small flies (Borborids, Limosina sp. and a few Sciaras), some pupae and several Staphylinids in and about the pail September 11. There were also many Psychoda alternata Say, about the pail September 25.

The new pail placed in the house August 3 contained young mushrooms the 23d. There were a few small flies on the surface. September 11 the contents were saturated, slightly rotted and were frequented by a few small flies. A Musca puparium was also found. There were some small mushrooms. September 27 numerous Psychoda alternata Say, were observed in and about the pail.

Station 18. June 29 there were no signs of flies at this station. July 8 there was no evidence of maggots being present though the pail was more moist than those at stations 6 and 23. July 17 there was much fungus on the manure though no flies were observed, not even Sciaras. The same was true July 21 and 25. August 3 there were a very few small flies on the margin of the pail but no evidence of larvae. August 23 there were a few small flies, probably Limosina and Sciara and several clusters of larvae, the latter being much less abundant than at stations 6 and 23. September 11 a few small flies and dipterous larvae were seen. The larvae were probably those of Sciara and Limosina. Psychoda alternata was reared from this pail, also a species of Scatopse. September 27 Psychoda alternata was rather abundant about the pail.

The new pail placed in the house August 3 was frequented by only a few small flies on the 23d. There was no evidence of larvae being present. September 11 only a few small flies, mostly Sciara and Limosina were seen. There were a few mushrooms in the pail. September 27 Psychoda was rather abundant.

Station 12. June 29 there were no signs of flies and the same was true July 8 though the pail was fully as moist as the others. July 17 conditions were practically the same as at station 18 though with perhaps less life, only a few mites being observed. Fungus was rather abundant on the manure. July 21 and 25 no flies were observed. August 3 neither flies nor larvae could be found. August 23 there were a few small flies

and several groups of larvae. The presence of these insects is possibly explained by a small amount of light being admitted through a recent mousehole made from near station 6. September 11 there were a few small flies and dipterous larvae together with two Glischrochilus quadriguttatus Fabr. September 27 Psychoda alternata was somewhat numerous about the pail.

The new pail placed in the house August 3 contained one or two small flies the 23d. September 11 there were a few small flies and several dipterous larvae from which a Drosophila was subsequently reared. September 27 Psychoda alternata was somewhat abundant.

Summary. A careful scrutiny of the above records will show that while Musca domestica and its larvae were found at both stations 23 and 6 there were none to be seen at stations 18 and 12. Furthermore, the house fly was much more abundant in the pail just outside the house though the latter was in a somewhat sunny place and owing to frequent rains and rather low temperature, full of water practically all the time. In this connection it is interesting to note that this pail with its saturated contents was much more attractive than similar pails within containing manure in a moist or rather wet condition. It may be worthy of note in passing, that the one place where the writer found house flies literally swarming during the past summer was in a barn cellar where hogs were running over thoroughly saturated excrement. There was a marked difference in the number of small flies occurring in the pail at station 18 as compared with the number found at station 6 and it is probable that there would have been an almost equally great difference between the abundance of the dipterous fauna at station 12, the darkest point of the house and station 18, which at midday had an illumination which might be characterized as twilight, had it not been for the mouse burrows admitting light.

The above data, while not so conclusive as could be desired, shows that the house or typhoid fly does not breed freely in darkness. This pest exhibits a decided preference for sloppy filth in light places. It is practical and thoroughly in accord with the best agricultural practice to either draw out and spread manure at frequent intervals, or to store it in cellars or sheds. The relatively cheap cement underpinning makes it comparatively easy to construct dark cellars, places where

manure or other fly-breeding material can be kept without producing swarms of flies. These measures, while particularly adapted to the farm will also prove of service in villages and cities.

Brown tail moth

Euproctis chrysorrhoea Linn.

This insect, to the consternation of our horticulturists and nurserymen, was brought into New York State by the thousands with importations of French seedlings in January 1909. Thanks to the radical measures adopted by the Commissioner of Agriculture on the recommendation of the Entomologist and his associates at Ithaca and Geneva, this pest, so far as can be ascertained, has not become established as a result of this recent introduction. The emergency existing in consequence of this wholesale importation made it extremely desirable to find some treatment aside from the removal and burning of the winter nests and their inhabitants, which could be relied upon to destroy any caterpillars escaping the inspector's eye. The experiments detailed on following pages show in a striking manner the futility of depending upon any method of fumigation with hydrocyanic acid gas for the purpose of destroying active caterpillars, not to mention the more resistant dormant larvae.

Another infestation. The danger of this voracious leaf eater becoming established in New York was strikingly emphasized June 16 by nursery inspector T. F. Niles of the State Department of Agriculture finding a small colony of nearly full grown larvae on the estate of W. W. Cook at Port Chester, N. Y. A personal examination by the writer, in company with Messrs Atwood, Niles and other representatives of the Department of Agriculture on Saturday, June 19, resulted in finding about six more full grown larvae, making a total of 16 in all. The infestation, so far as careful inspection showed at that time, was limited to seven clumps of Crataegus located in the northwest corner of a large cultivated field which had been planted extensively with ornamental shrubs and trees. The caterpillars were undoubtedly brought into the State with the Crataegi which had been purchased by Mr Cook from the Arnold Arboretum. Subsequent inspections on the 20th and 21st resulted in finding no more larvae. It was decided, owing to the dangerous nature of the pest, that drastic measures were by all means advisable. All herbaceous vegetation within 100

feet of the thorn trees where larvae were found was destroyed by means of a cyclone burner (a cyclone nozzle burning crude oil) and the bare soil repeatedly burned over in this manner, except that between the young trees the surface soil was removed prior to the treatment. Before this operation the Crataegi and other trees within the infested area were carefully inspected, banded with tree tanglefoot and then repeatedly sprayed with a petroleum whale oil soap solution for the purpose of destroying any caterpillars which might possibly have escaped observation. The remains of a winter nest of a brown tail moth was discovered on the other side of the estate and similar measures pursued, except that the surface soil was removed prior to the burning. This latter work was done so thoroughly as to destroy grass roots in firm vigorous sod. The insecticide was strong enough to cause quite a little dropping of the foliage though the trees were not materially injured.

These precautions were supplemented by the operations of trap lanterns near the two centers of infestation from the latter part of June to July 16, for the purpose of attracting thereto and capturing any individual which might possibly have escaped the treatment described above. Nothing suspicious came to the lights or was observed in the vicinity, despite repeated examinations made of trees, poles and buildings in the vicinity. The captures with the trap lantern in the center of the larger burned area were remarkably scarce, especially for the first few days after the burning.

A general survey of the vicinity September 21st resulted in finding nothing suspicious and showed further that none of the trees in the treated area had been seriously affected.

Destructiveness. The caterpillars of the brown tail moth are exceedingly voracious, feeding by preference on the foliage of apple, pear, plum, wild cherry and white oak, though they thrive on both soft and hard maples and also elm. These pests have been exceedingly abundant in recent years in the Middlesex fells and other extensive wooded areas north or northwest of Boston, Mass., defoliating large tracts of white oaks. Numerous apple and pear trees throughout the infested region have been killed or are in a dying condition and bear striking testimony to the voracity of this caterpillar. Furthermore, the irritating hairs blowing from the nests or cocoons are constantly causing serious discomfort on account of the severe irritation produced. This insect, in association with the

gipsy moth caterpillar, has materially reduced real estate values in some of the worst infested sections.

Watch for the pest. The material injuries outlined above emphasize the necessity of keeping a close watch for the appearance of this insect, to be followed by prompt repressive measures if we would avoid extended losses. The Entomologist, in past years, has sent out a warning placard illustrating this insect and the gipsy moth in colors and giving the salient characteristics of both species. These placards may still be obtained upon application. A general publication [N. Y. State Mus. Bul. 103] has also been prepared and will be sent to interested parties.

Salient characters. The moths are snow-white, brown tailed insects with a wing spread of 1¼ to 1½ inches. They are abroad in early July, fly readily and may be carried considerable distances by favorable winds.

The eggs are deposited in midsummer on the under side of leaves, in patches covered by brownish hairs or scales. The young caterpillars appear in August and feed for the most part in the tops of trees. They occur by preference on wild cherry, pear, apple, maple, elm and white oak, constructing a very characteristic, close, firm web nest [pl. 22] differing greatly from the loose, open nests inclosing many leaves, of the fall webworms and easily distinguished from those of the common tent caterpillar because they are at the tips of small limbs and not in the crotches.

The brown tail moth caterpillars winter in firm nests inclosing a few leaves and invariably at the tips of twigs. Consequently, winter is one of the most favorable seasons for the detection of this pest. We would urge every one residing in a locality liable to infestation, to keep a close watch for the presence of these characteristic winter nests.

The nearly full grown brown tail moth caterpillar, found only in late May and early June, is about an inch long, a bright tawny or orange-brown color, with a conspicuous row of white spots on either side and two bright red spots on the back near the posterior extremity.

Experimental work. The following experiments with hydrocyanic acid gas were conducted during the winter and early spring, in an effort to find a reliable method of freeing nursery stock from any caterpillars which might escape the inspector's eye. The larvae used for experimental purposes were obtained

from nests taken from imported French stock and were allowed to remain in a warm office at least over night. The experiments detailed in series 1 to 4 inclusive, were performed in ordinary two-quart fruit jars, healthy caterpillars being removed from the nests and placed on blotting paper a short distance from the necessarily small generators. The small scale upon which the experiments were conducted rendered it possible to make a large series of tests and in a relatively short time. Special care was taken in the experiments detailed in series 2, to prevent the exposure of the jars to direct sunlight, since that undoubtedly accentuates the action of hydrocyanic acid gas. The records in series 4 give the results of parallel tests between glass jars exposed to ordinary light and those kept in darkness. The caterpillars in this last series had been in a warm room for over 24 hours, having been shipped from Rochester January 26 and arriving in Albany the morning of the 27th.

The experiments in series 5 are particularly instructive, since they were performed in a zinc lined cubical box 3 by 3 by 3 feet and containing 27 cubic feet. The overlapping edges were carefully soldered and the removable side, its face being lined with zinc, was held in place by a series of 8 bolts with thumb nuts. An air-tight joint was secured by clamping the cover down on to a strip of rubber ¼ inch thick and 1 inch wide. Two drams of cyanide of potassium for each charge corresponded very closely to 1 ounce for 100 cubic feet of space, the slight excess probably being offset by the ¼ inch rubber strip adding slightly to the capacity of the box. Ten larvae were placed in each of several mica lamp chimneys suspended horizontally at different hights or placed in different portions of the box, the open ends being covered by coarse cheese cloth held in place by elastic bands. The larvae used in experiments 1 to 7 of this series were received early in February and kept in a cool place till needed. Practically none had begun to crawl and they were therefore in a hibernating condition. Those employed in experiments 8 to 16 were on importations received in March and had begun to leave the nests in considerable numbers.

A number of active caterpillars were placed in an ice box in early April and kept at a low temperature for six days. These, though apparently in a hibernating condition, proved no more resistant to hydrocyanic acid gas fumes than active larvae.

Experiments with brown tail moth caterpillars

Series 1, *January* 15, 1909

Number of experiment	Grains cyanide	Hours exposed	Number of larvae	Observations at close of fumigation	Later observations
4	1	3	4	All dead	Same, 18th, 20th
5	1	3	4	"	" " "
8	1	1	4	Apparently dead	1 alive on 18th and 20th
9	1	21	4	Dead	Same, 18th and 20th
1	½[1]	1	4	2 alive	4 alive 18th and 20th
2	½	21	5	Dead	Same, 18th, 20th
3	½	3	4	"	" " "
10	½	3	4 & nest	3 alive 18th 2, 20th	Alive in nest
11	½	6	4 "	Exposed caterpillars dead	All exposed caterpillars dead 18th, 20th most in the nest dead
6	⅛	3	4	Apparently dead	Apparently dead 16th, 1 alive the 18th, all dead the 20th
7	⅛	21	4	All dead	Same, 18th, 20th
12	⅛	3	4 & nest	2 alive	2 alive the 20th, those in nest alive
13	⅛	6	4 "	Exposed caterpillars dead	Same, 18th, caterpillars in nest alive

Series 2, *January* 20, 1909

1	⅛	6	8	Dead	Same, the 21st
3	⅛	6	8	"	" " "
6	⅛	5	8	"	" " "
7	⅛	5	8	"	" " "
8	⅛	4	8	"	" " "
11	⅛	4	8	"	" " "
12	⅛	3	8	"	" " "
13	⅛	3	8	"	" " "
2	⅛	6	8	"	" " "
4	⅛	6	8	"	" " "
5	⅛	5	8	"	" " "
9	⅛	5	8	"	" " "
10	⅛	21	8	"	" " "
14	⅛	4	8	"	" " "
15	⅛	4	8	"	" " "
16	⅛	21	8	"	" " "
17	⅛	3	8	"	" " "
18	⅛	3	8	Apparently dead	1 alive 21st, 22d

Series 3, *January* 21, 1909

1	⅛	1	8	Dead	Same, the 22d
2	⅛	1	8	"	" " "
5	⅛	2	8	"	" " "
6	⅛	2	8	"	" " "
9	⅛	3	8	"	" " "
10	⅛	4	8	"	" " "
3	⅙	1	8	Alive	Same, 22d, 23d
4	⅙	1	8	"	" " "
7	⅙	2	8	Apparently dead	Several alive the 23d, small piece of web present
8	⅙	2	8	Dead	Same, the 22d
11	⅙	3	8	Apparently dead	Several alive the 23d, pieces of nest present
12	⅙	4	8	Dead	Same, the 23d

Series 4, *January* 28, 1909

1	⅛	3	10	All apparently dead	All dead the 31
2	⅛	3	10	" " "	" " "
3	⅛	3	10	" " "	" " "
4	⅛	2	10	" " "	" " "
5	⅛	3	10	" " "	" " "
6	⅛	3	10	" " "	" " "

[1] ½ grain equals approximately 1 ounce to 100 cubic feet of space.

Experiments with brown tail moth caterpillars (*continued*)

Series 5, *March* 2, 1909

No. of experiment	No. of cage	Hight of cage in inches	Drams cyanide	Hours exposed	No. of larvae	Observations at end of fumigation	Later observations
1	1	26	2[1]	2	10	1 alive	2 alive March 3, 3 alive March 5
1	2	20	2	2	10	2 "	4 alive March 3, 3 alive March 5
1	3	13	2	2	10	1 "	7 alive March 3, 5 alive March 5
1	4	6	2	2	10	1 "	7 alive March 3, 4 alive March 5
1	5	1	2	2	10	1 "	3 alive March 5
1	6	0[2]	2	2	10	6 "	5 alive March 5
1	7	0[3]	2	2	10	1 "	2 alive March 3, 3 alive March 5
2	1	26	2	2	10	1 "	2 alive March 3, 1 alive March 5
2	2	20	2	2	10	4 "	4 alive March 5
2	3	13	2	2	10	1 "	2 " " 5
2	4	6	2	2	10	1 "	2 " " 5
2	5	1	2	2	10	Apparently all dead	1 " " 5
2	6	0[4]	2	2	10	Apparently none alive	1 " " 5
3	1	25	2	3	10	All apparently dead	1 alive March 4, 5
3	2	13	2	3	10	All apparently dead	All dead March 5
3	3	1	2	3	10	All apparently dead	1 alive March 4, 2 alive March 5
3	4	0[5]	2	3	10	All apparently dead	All dead March 5

[1] Two drams equals 1 ounce to 100 cubic feet of space.
[2] Cage with end against side of box.
[3] Standing on end on the bottom of fumigation box.
[4] Cage laid on bottom with both ends unobstructed.
[5] Cage lying on bottom of box but in the far corner.

Experiment 4, March 3, is a duplicate of number 3. At the close of fumigation the larvae were apparently all dead, this finding being confirmed by observations March 5.

Experiment 5, March 4, is practically a duplicate of experiments 3 and 4, except that the exposure was for but 1 hour and 4 drams of cyanide were used instead of 2 drams. At the close of the fumigation a few larvae in cages 1 to 3 were apparently alive, while those in number 4 appeared to be dead. March 5 cage 1 had 5; cage 2, 5; cage 3, 7 and cage 4, 9 living larvae. March 6 there were 4 living larvae in cage 1; 4 in cage 2; 6 in cage 3 and 9 in cage 4.

Experiment 6, March 4, was a duplicate of experiment 5, except that the exposure was continued for 2 hours. All the larvae were apparently dead at the end of the fumigation period. March 5 there was 1 living larvae in cage 1; 5 in cage

3 and apparently none in cages 2 and 4. March 6 there were 2 living larvae in cage 1; 8 in cage 3 and 1 in cage 2, all being dead in cage 4.

Experiment 7, March 4, was a duplicate of experiment 6. March 5 there was 1 living larva in cage 1 and all appeared dead in cages 2 to 4. March 6 there was 1 living larva each, in cages 1, 2 and 3, while all were dead in cage 4.

Experiment 8,[1] tried March 29, the exposure being 3 hours and the amount of cyanide 4 drams. The caterpillars were all apparently dead at the end of the fumigation, the finding being confirmed by observations March 30th.

Experiment 9, March 28, the exposure being 2 hours and 4 drams of cyanide being employed. The caterpillars appeared to be dead at the end of the fumigation March 30th. One was barely alive in cage 3 and all were dead April 1st.

Experiment 10, March 30, with an exposure of but 2 hours and 2 drams of cyanide. The larvae were apparently all dead at the conclusion of the experiment. March 31st there was 1 alive in cage 1; 5 alive in cage 2 and 2 alive in cage 3. April 1, 1 was alive in each of cages 1 and 2 and 2 in cage 2. April 2, 1 was alive in each of cages 1 and 2, the others being dead.

Experiment 11, March 30, with an exposure of 1 hour and 2 drams of cyanide. All the caterpillars were apparently dead at the close of fumigation. March 31 all were alive in cages 1 and 2 and but 3 dead in cage 3. April 1, 8 were alive in cage 1 and all in cages 2, 3 and 4. April 2, 8 were alive in cage 1; 9 in cage 2 and 4 in cage 3.

Experiment 12, tried March 31st, exposure 1 hour with 6 drams of cyanide. All were apparently dead at the end of fumigation. April 1, 1 was alive in cage 3; all were dead April 5.

Experiment 13, March 31, an exposure of but 1 hour with 6 drams of cyanide. April 1 there was 1 larva alive in cage 1; 5 in cage 2 and all in cage 3. April 2, 3 were alive in cage 1, 5 in cage 2 and all in cage 3. April 5, 1 larva was alive in cage 2 and 7 in cage 3.

Experiment 14, March 31, an exposure of ½ hour with 6 drams of cyanide. April 1 all the larvae were alive in cage 1,

[1] The caterpillars used in this and succeeding experiments of this series were taken from nests on recently imported stock and received at Albany, March 27, 1909.

7 in cage 2 and all were dead in cage 3. April 2 all were alive in cage 1, 8 in cage 2 and 3 in cage 3. April 5, 4 were alive in cage 1; 2 in cage 2 and 1 in cage 3.

Experiment 15, April 1, the exposure being 1 hour with 6 drams of cyanide. April 2, 5 were alive in cages 1 and 2 and 2 alive in cage 3. April 3, 4 were alive in cages 1 and 2 and all dead in cage 3. April 5 none were alive in cages 1 and 3 and 3 alive in cage 2.

Experiment 16, April 1, exposure 1 hour with 8 drams of cyanide. Examination April 2 to 5 showed that all had been killed.

Experiments with scalecide

January 20, 1909

Experiment	Dilution	Time	Number of caterpillars	Observations
1	1–20	1 min.	10	Dead, the 21st
2	1–20	½ "	10	" " "
3	1–40	1 "	10	Alive the 21st, 5 alive the 22d
4	1–40	½ "	10	Dead the 21st, 22d

Observations on experiments. Series 1 apparently shows that nearly dormant free caterpillars can be destroyed by 3 hours fumigation, using 1 ounce of cyanide to 100 cubic feet of space. A scrutiny of the records also reveals the fact that this amount of cyanide can not be depended upon to kill the insects within their nests. One half this strength, namely 1 ounce to 200 cubic feet of space can not be relied upon to destroy free caterpillars if the fumigation be continued 3 hours though all succumb after a prolonged exposure to the gas such as 21 hours.

Series 2 apparently indicates a most satisfactory method of destroying these pests were it not for the fact that the caterpillars, prior to the experiments, had been in a warm room of the office for several days and were therefore aroused to nearly normal activity.

Series 3 apparently gives very satisfactory results if the fumigation be continued even 1 hour, provided 1 ounce of cyanide be used to each 100 cubic feet of space. Unfortunately, these caterpillars had been exposed to a moderate temperature for at least a day and were hardly in the hibernating condition.

Series 4 is practically a duplicate of series 3 and apparently gave very satisfactory results.

Using the data obtained in the preceding series as a guide, more elaborate experiments were conducted in the cubical box and its cages described on a preceding page. The larvae in this series had not begun to crawl to any extent and were therefore practically in a hibernating condition. It will be seen by reference to the table that fumigation for 3 hours with 1 ounce of cyanide to 100 cubic feet of space can not be relied upon to destroy all the caterpillars in the various cages though the diffusion of the fumes was checked by no more serious obstacle than the open mesh of cheese cloth. In fact, the lack of uniform action in the different cages and the apparently feeble penetrative power of hydrocyanic acid gas was something of a surprise. A reference to the records of the various experiments under this series shows that the results are more or less contradictory and unsatisfactory, plainly indicating the unreliability of hydrocyanic acid gas for the destruction of the hibernating caterpillars of the brown tail moth. This is especially true if the caterpillars are in their winter nests and not freely exposed.

The tests with scalecide diluted one part to 20 resulted in the death of all the caterpillars even when the period of immersion was limited to half a minute.

Codling moth

Carpocapsa pomonella Linn

The codling moth must be regarded as one of the most injurious of our fruit insects, since it occurs throughout the apple-producing sections of this country. The apple worms or young of this pest may be found in from 25 to 60 or more per cent of the fruit in many regions. This gives an idea of how very injurious it may be, since the value of an apple is seriously affected by the presence of the apple worm. Dr S. A. Forbes, State Entomologist of Illinois, in 1887 estimated the annual loss caused by this insect in that state at $2,375,000. A similar calculation for Nebraska in 1892 placed the damage at $2,000,000, while in 1898 the late Prof. M. V. Slingerland estimated the annual loss caused by this insect on the apple and pear crop of New York State at $3,000,000. An estimate of the injury for the entire United States, made in 1908, puts the damage at $12,000,000; aside from the cost of spraying, which latter amounts to from $3,000,000 to $4,000,000 [Quaintance '08]. Those conversant with the situ-

ation will agree that the above figures are conservative and probably greatly understate the actual loss.

Early history

It should not be understood that the apple worm or codling moth is a recent insect pest, though there was a time when this species was unknown in America. Undoubtedly Cato had this form in mind when writing about wormy apples nearly 200 years B. C. Pliny also mentions this pest, though the true history of this insect, according to the late Professor Slingerland, begins with the brief account of Goedaerdt, published in 1635. Several European writers discussed the insect in the next and following century.

The first notice of this species in American literature was occasioned by the rearing of a moth from plums instead of the familiar plum curculio. Dr T. W. Harris, our first economic entomologist, established in 1832 the identity of the American apple worm with the well known European species. Subsequently, numerous accounts were published by earlier workers, while the developments of recent years have shown the wisdom of making more careful studies of this species. The result is an enormous literature, much of it a repetition of facts ascertained by early investigators. The more recent discussions of this insect have almost invariably been preceded by original investigations and have therefore added something to our knowledge of this pest.

Origin and distribution

This insect is doubtless a native of southeastern Europe, though it is now known to occur in almost every part of the world where apples are grown. South Africa and Australia made determined efforts to exclude the pest and were successful for some years. This moth was probably brought into the United States in the latter part of the 18th century, since it was not recognized in America till 1819, at which time wormy fruit was common in the vicinity of Boston. It was prevalent in the New England States by 1840 and was at that time well established in central New York. It was recognized in Illinois in 1849, Iowa about 1860, Utah 1870 and appeared in California the spring of 1874. There may be a few isolated fruit regions in the far West where the insect has not yet become established. It is only a question of time before it will make its way to these remote places.

The wide dissemination of this insect is undoubtedly accomplished by the shipment of infested fruit, or by means of infested boxes and barrels. This latter is easy, since the apple worms spend the winter in well protected cocoons.

The experience of the last 40 years has abundantly demonstrated the practicability of control measures. The problem before us at the present time is to determine the most economical method of accomplishing this desirable result. A knowledge of the insect and its habits is a necessary preliminary to success.

Life history and habits

Summary of habits. It is well known that the apple worm winters in a tough, silken cocoon, frequently found under the rough bark of trees. With the advent of warm weather in the spring, which in New York means late April and early May, the caterpillars begin to transform to pupae, and a week or 10 days after the blossoms drop, the moths commence to emerge and continue to appear throughout the greater part of June. The minute, whitish eggs, as determined by recent investigations, are deposited largely upon the leaves, though a number may be found on the young fruit. These hatch in about a week and, as a consequence, the young worms of the first brood may be entering the small apples from early in June to nearly the end of the month or even later. The caterpillars require about four weeks to complete their growth, at which time they desert the fruit, wander to a sheltered place, spin a cocoon, transform to pupae, and in about two weeks, namely, the last of July or in early August, another brood of moths appear. These in turn deposit eggs which hatch in due time and the young larvae enter the fruit. A larger proportion of this brood enter at the side of the apple than is the case with the first generation of larvae. Two broods appear to be the rule in the northern fruit-growing sections of the United States at least, though some investigators claim a third in the southwest, in particular.

It is important for the fruit grower, if he would obtain the best results in his efforts to control this pest, to know more than the bare outline given above. We will therefore proceed to discuss certain phases of the life history of the insect in some detail.

Food habits. This insect is best known as an apple pest, though its occurrence in pears is by no means uncommon. Some crab apples at least, and quinces are very subject to injury. It is also known to infest peaches, plums, prunes, apricots and cherries.

There are records of this species having been reared from chestnut and walnut, though in some instances at least, the evidence is not so conclusive as might be desired.

Hibernation. The codling moth winters as a caterpillar in a silken cocoon spun in some sheltered retreat, especially under the bark of trees. The full-grown caterpillar usually excavates an oval cavity about half an inch long, occasionally penetrating to the living tissue, in the bark and spins its cocoon. This latter probably occurs frequently under boards, rubbish, fences etc., in the vicinity of infested trees. Simpson ['01] observed a number of cocoons under clods of earth and in crevices, while Sanderson ['08] found that 30% of the cocoons on seven trees in a badly infested, old orchard were on the main branches, the remainder being on the trunk, the great majority of the latter occurring either close to the crotch or within a foot of the ground. The occurrence of cocoons in the soil or in the grass under infested trees is certainly exceptional, since a careful examination by Beal in 1875, resulted in finding none. It is well known that worms leaving infested fruit after it is barreled or stored, will spin their cocoons in crevices and angles of barrels or in almost any convenient shelter. They display a marked preference for the folds of fabrics, a habit turned to good account when we employ burlap or other bands. The apple worms have even been known to injure books in an effort to find a safe place in which to transform.

It only requires casual observation to show that winter is a time of great mortality for apple worms. A tree badly infested in the fall may be nearly cleared of the pest in the spring. An examination of seven badly infested, old trees [Sanderson '08] showed that out of 269 larvae, only 5% were alive, 87% having been destroyed by birds, 4% killed by fungus and 3% apparently succumbing to cold.

Pupation. Transformation to the pupa is coincident with the appearance of warm weather and occurs in New York State [Slingerland '98] the latter part of April and in early May. Sanderson ['08] records transformation to this stage at Durham, N. H., in 1908 from May 20 to June 9, and the preceding year, May 18 to June 23, the average duration of this stage being 16 days. The New Hampshire records, it should be observed, are later than those of Ithaca, N. Y., the divergence being easily accounted for by the difference in latitude and climate.

The moth and its habits. The moth has a wing spread of about ¾ of an inch and is an obscure, grayish brown and bronze color. Near the tip of the forewing there is a large, dark brown spot marked with streaks of bronze or gold. The male is distinguished by the black pencil of hairs on the upper surface of the hind wing and a black spot on the under surface of the forewing. The emergence of the moths from the cocoon, like the transformation of the larvae to the pupae, extends over a considerable period.

There is a correlation between the flight of the parent insects and the blossoming of the apples, though the latter varies somewhat according to weather conditions and the variety. Observations extending over three years [Sanderson '08] show that the first moth in New Hampshire appeared from a few to about 10 days after the petals fell, the majority of the moths being abroad two or three weeks after the blossoms dropped and the last adults being observed nearly a month after the falling of the bloom. The records of several observers show that moths may live from two to about four weeks. The parent insect is nocturnal though not attracted to lights to any extent, feeds freely upon cut fruits and sweets, and on account of its colors harmonizing with the bark upon which it rests, usually escapes observation.

It is difficult to reconcile Melander's belief ['08] that the codling moth may be so local as to even have a home tree, with the contradictory results obtained in some experiments on adjacent trees, where the infestation appeared to increase with the number of sprayings. Professor Ball ['04] states that a few moths may be carried by the wind several miles. It is interesting to note that observations by Cordley ['02] suggest that the moths may not deposit eggs in Oregon when the evening temperature falls much below 60° F.

Eggs. The small, whitish or yellowish eggs of this insect may be deposited upon the foliage or fruit, and to the unaided eye, appear, when fresh laid, much like a minute drop of milk about the size of a small pin head. A careful study [Sanderson '08] shows that out of 796 eggs actually observed, 787 were deposited upon the leaves, nearly equal numbers being upon the upper and under surface, while only seven were seen on the fruit and five on the bark. These eggs were from a few to 16 or even 28 inches from any fruit, with an average distance of approximately 9 inches. The record shows that the moths make no particular effort to deposit the eggs upon the fruit, and also that large num-

bers may be laid on leaves of barren limbs. There was nothing in the records to show that proximity of eggs had any material influence upon the fruit becoming infested. Similarly, Pettit ['04] found some 86% of the eggs on the foliage. Females may deposit from 29 to 136 eggs, the average running probably from 60 to 75. According to Sanderson ['09] the laying of eggs may be considerably delayed by cool weather. Hurst ['09] holds that the eggs may be killed if the temperature drops to 36° F. Thus a cool period in late May or early June may result in comparatively few wormy apples. The duration of the egg stage depends somewhat upon temperature conditions and in New Hampshire [Sanderson '08] it was found to be a trifle over eight days. Simpson ['03] gives the average as 11 days.

The appearance of the majority of the moths two to three weeks after the dropping of the petals and, adding to this the time necessary for the hatching of the eggs, shows that the major portion of the young apple worms can not attack the fruit till three to four weeks after the falling of the bloom.

Habits of the larva. The young larva, which is only about 1/16 of an inch long, whitish, black spotted and with a black head, feeds [Sanderson '08] first upon the foliage, mining into the leaf at the angles of the midrib and branch veins and gnawing the softer portions of the surface. It is possible that some may attain maturity without entering fruit, since Dr Headlee succeeded in obtaining a pupa from one which grew to full size in a water sprout. Usually the appetite for fruit asserts itself early and the young larva starts in search of an apple. The blossom end is highly favored, since some two thirds or more of the total enter at this point, feeding first in the calyx cavity and then making a more or less direct path to the core. The young larvae exhibit a marked preference for the seeds and the tissues in the immediate vicinity. Rarely do we find more than two worms coming to maturity in the same apple, even on very badly infested trees. The time spent in the apple is variable, several investigators giving records from 10–14, 16–24, 20–30, 25–30 and 34 days. The average is probably not far from four weeks, though the duration of this stage is dependent to some extent upon the temperature. The full-grown apple worm is about ¾ of an inch long, with a conspicuous, brown head and a whitish or frequently pinkish body. It forsakes the apple upon attaining maturity and seeks some secure place prior to excavating a

cavity, if this be necessary, and spinning its rather firm, whitish cocoon. A large percentage, over 90 in some instances [Hurst '09], desert the fruit while it is still on the tree and crawl down the limbs and trunk. Gillette ['00] has shown that there may be some movement or migration of the larvae in the spring prior to the transformations to the adult.

Second generation. The early larvae, at least of the first brood, completing their growth from the middle to the latter part of July, transform, shortly after spinning up, to pupae and produce moths which, in New York State, appear late in July or during August. The second brood larvae are much more likely to enter the fruit at the side than is the case with the first generation. Very frequently a portion of a leaf attached to the side of the apple, is utilized as a point of entry or the apposed surfaces of two apples hanging side by side may be similarly employed. The evidence at hand shows there is only a partial second brood in New Hampshire, a partial to a full second brood in New York State, while in the southwest there are those who claim a partial third brood.

Natural enemies. The codling moth, despite its destructiveness, is subject to attack by a number of natural enemies, some of which are exceedingly efficient. Those examining trunks of apple trees in the spring, very frequently come across the characteristic cocoons of this insect, many of them with an irregular, jagged hole showing where a bird had extracted the inhabitant. The destruction of 87% [Sanderson '08] of such cocoons is striking testimony to the efficiency of these forms. The downy woodpecker and the nuthatchers are among the most beneficial. It is probable that all woodpeckers frequenting orchards feed on codling moth larvae. Other birds known to do so, in addition to the above named, are the black-capped titmice, wrens, bluebirds, crows, blackbirds, king birds, swallows, sparrows, chickadees and jays. A bat has been observed in California diligently capturing moths.

There are a number of predaceous and parasitic insects known to prey upon this fruit pest. The larvae of the soldier beetles, *Chauliognathus pennsylvanicus* and *C. marginatus* attack the apple worm. The 2-lined soldier beetle, *Telephorus bilineatus*, an ally of the preceding and likewise common, has similar habits in its larval stage. Two other related forms, *Trogosita corticalis* and *T. lati-*

collis have similar habits. Two ground beetles, Pterostichus californicus, Calathus rufipes, and several Dermestid or scavenger beetles, such as Trogoderma tarsalis and Perimegatoma variegata have been recorded as enemies. Other predaceous beetles undoubtedly destroy some larvae. A solitary wasp, Ammophila, in Utah, uses codling moth larvae to stock its nest, while Sphecius nevadensis was observed capturing these larvae in California.

Though the egg of the codling moth is so very tiny, it is not too small for the development of a small egg parasite known as Trichogramma pretiosa: The late Professor Slingerland records obtaining four from one egg. The delicate long sting, Macrocentrus delicatus has been reared from this insect. An ally known as Pimpla annulipes subsists upon this host. A parasitic fly, Hypostena variabilis is recorded as one of the enemies of the codling moth. These insect enemies, though numerous in variety, are rarely abundant enough to have any very material influence in reducing the numbers of this insect.

We have heard in late years, considerable in relation to a parasite, Caliephialtes messor Grav. recently introduced in California in the hope that it would prove of material service in controlling the codling moth. We regret to state that the developments of the last year or two have been disappointing, and it is doubtful if this species will ever be ranked as an important enemy of the codling moth in this country.

Control measures

Destruction of fallen fruit

The destruction of fallen fruit is by all means advisable provided it does not involve too much labor or expense. Unfortunately, a considerable proportion of the apple worms may desert the fruit on the trees and therefore escape destruction in this manner.

Trap lights

Trap lights have been warmly advocated at irregular intervals, though so far as careful investigations show, the benefits resulting from their use are inappreciable. Garman, in a series of experiments, found only 1.6% of his captures to consist of this species.

Banding

In the use of bands we take advantage of the apple worms' predilection to search out retreats, especially under fabrics on the trunk of the tree and, as a consequence, a considerable proportion may be captured in this way. It has been found by careful experiments that a large percentage of the worms infesting apples may desert the fruit while on the tree, crawl down the limbs and establish themselves in suitable retreats, rather than drop from the trees, crawl to the base of the trunk and ascend. There is no doubt as to the benefit resulting from bands carefully tended throughout the season. Unfortunately so much labor is involved that this method finds comparatively slight favor in the Eastern States.

Scraping the trunk

This is undoubtedly of service, since it reduces the number of retreats where codling moth larvae can hibernate in safety. There is a question as to the actual benefit to be derived, as repeated examinations in the orchard have shown that a very large percentage of the apple worms hibernating under the bark are destroyed by birds and other natural agents.

Screening fruit cellars

More or less wormy fruit is carried into storehouses and fruit cellars, and the larvae escape and hibernate in such places. It is advisable, where fruit trees are in the vicinity, to prevent the moths escaping in the spring, by closely screening windows and doors.

Spraying with poisons

The experience of the last 30 years has abundantly demonstrated the efficacy of poisoned sprays, provided the applications are timely and thorough. Many experiments conducted in the varied fruit sections of this country show that it is possible by this method alone, to obtain 90, 98 or even 99% of worm-free fruit, much depending upon the time when the work is done and the thoroughness of the treatment.

Materials. The poisons most generally employed against the codling moth in New York State at least, are paris green, arsenite of lime or arsenite of soda, and arsenate of lead, listing the materials in the order in which they were brought to notice. There is no question as to the value of paris green and its close allies, particularly if used in connection with bordeaux mixture,

since the latter aids materially in keeping the preparation upon the trees. Thorough and continuous agitation is necessary when paris green is used and should not be overlooked with other poisons. The arsenite of lime[1] is the cheapest poison which can be employed and has been extensively used in the fruit-growing sections of western New York. It is comparatively safe if used with bordeaux mixture. In recent years large amounts of arsenate of lead, usually a commercial preparation sold under a trade name, have been employed with great satisfaction. This poison is much more adhesive by itself than either paris green or arsenite of lime, and on account of its insolubility is much less likely to injure the foliage by burning. It is one of the safest poisons which can be employed. Arsenate of lead should be purchased on a guaranty as to the amount of arsenic contained, since there is considerable variation between the different brands. It is not particularly profitable for the fruit grower to pay for filler. It is the poison he is after.

The experience of the last two seasons has shown that it is possible to use a poison, especially arsenate of lead, with a dilute lime-sulfur wash (one of the standard commercial washes diluted with 30 parts of water). The advantage of this combination lies in the fact that so far this dilute lime-sulfur wash has caused no material injury to either foliage or fruit, while it has proved most effective as a fungicide and the poison has in no manner lost its efficiency as an insecticide. It should certainly be tried further, though the results thus obtained do not warrant unmodified recommendation.

A word as to the possibility of ultimate injury to orchards receiving one or more applications annually, of an arsenical poison. Prof. William P. Headden of Colorado has published a bulletin giving a warning in regard to this matter and stating that in his opinion, many trees in that state were being killed by applications of poison. It is but fair to state that other investigators in an adjacent state and one in New York State attribute the injury to other causes. So far as the writer can

[1]Arsenite of lime may be prepared by dissolving 1 pound of white arsenic and 4 pounds of sal soda (carbonate of soda, washing soda) in 1 gallon of water by boiling in an iron vessel 15 minutes or till the arsenic dissolves, leaving only a little muddy sediment. Add the water lost in boiling and use 1 pint of this stock solution to each 40 gallons of water to which 2 pounds of freshly slacked lime have been added, or a pint of the stock solution may be added to 40 gallons of bordeaux mixture. This stock solution will keep indefinitely in a closed vessel. It is very poisonous and should be properly labeled.

ascertain, the use of poison in Colorado and adjacent fruit-growing sections, has been much more liberal than in the East, and the probabilities are that similar trouble, if it be due to poison, will not manifest itself to any great extent in New York State for some years to come. Nevertheless, it is not only more economical but it is by all means advisable to bear this in mind when spraying and to endeavor to secure a maximum result with a minimum of poison.

Dry poisons. The application of poisons dry, frequently termed "dust spraying," has been warmly advocated in recent years, though careful experiments show that the dry method is less effective in controlling codling moth. It may be advisable in localities where the nature of the land or other conditions make it almost impossible to use the heavier outfit necessary for applications of liquids. The drifting or blowing dust is very annoying, since it is almost impossible to dodge it entirely, and furthermore, there is, in our judgment, more danger of ill effects to the operator resulting from the continued use of this material.

Apparatus. There are now on the market a number of good spray pumps and spraying outfits. The selection of any one to the exclusion of others, must be decided very largely by local conditions. The essentials in a spraying outfit, be it large or small, are ample power, sufficient mobility, plenty of hose and a nozzle extension or other arrangement so as to permit of the thorough and rapid covering of the foliage with the insecticide or fungicide. A tower is almost invaluable in a level orchard and of little service in a hilly one. We believe it advisable for the beginner to invest in a hand outfit and learn by actual experience whether his conditions justify the purchase of the much more efficient and correspondingly expensive power outfit.

The extended experience with spray apparatus of various kinds in eastern Massachusetts, has resulted in several improvements which may be of material benefit to our fruit growers. One of considerable utility is the long-tailed coupling, a device which does not reduce the diameter of the hose at the point of coupling, and furthermore permits the attachment of two broad bands to each portion of the coupling, thus preventing "blow offs" almost entirely. Another handy device is the "goose-neck," which is nothing more than a short piece of bent pipe attached to the usual horizontal connection, so that the hose

may be screwed to it at an angle of about 45° from the horizontal, thus obviating in large measure the tendency of the hose to break at the end of the coupling, owing to its hanging therefrom at a nearly right angle. High power outfits capable of developing 200 pounds pressure are being used in the gipsy moth work, with a solid stream nozzle, experience showing that on high trees at least, a very fair spray is secured under such conditions. This method could probably be used to advantage on large orchard trees.

Methods. There has been more or less difference of opinion as to the relative efficacy of a coarse or fine spray in work against the codling moth. This has culminated in recent years in some very strong statements made in favor of employing a rather coarse spray and an unusually high pressure in an effort to drive the poison into the lower calyx cavity, that is the cavity below the stamens. It is hardly necessary to remind fruit growers that after the white petals have dropped we have the green calyx lobes and within a ring of numerous upright, slender stamens surrounding the central, fleshy pistil. Below the stamens and at the base of the pistil there is an appreciable cavity [pl. 19, fig. 1]. This is the place, according to some authors, where the poison must be put if we would obtain fairly satisfactory results. One writer has even gone so far as to state that if spraying is not done in this manner the small apple worm is fairly safe, since it rarely feeds before it goes down into the lower cup, and that the poison sprayed on the outside will therefore not affect it. The claims for this method of spraying were so strong that the problem seemed one worthy of careful demonstration, and the writer therefore planned and conducted a series of experiments for the purpose of obtaining data upon this proposition.

Experimental work. The main purpose of these experiments was to test the relative efficiency of a coarse driving spray, such as that produced by a typical Bordeaux nozzle with a pressure of over 100 pounds in comparison with the fine, misty spray of the Vermorel nozzle and its various modifications so extensively used in the eastern United States.

Comparisons were made between single sprays of each of the above mentioned kinds applied just after the blossoms fell, between two sprays of each kind, one given just after the blossoms fell and the second just before the sepals closed and finally, between two such sprays and a third applied with a

Friend nozzle (an improvement of the Vermorel type) the last week in July for the purpose of destroying the second brood of the codling moth. The first test was duplicated in the orchard of Edward Van Alstyne at Kinderhook, N. Y.

Treatment of plots

Vermorel nozzles. Plot 1. An early spray just after the blossoms fall; plot 2, the same as above and a second spray before the calyx lobes close; plot 3, the same as plot 2 but with an additional spray, using a Friend nozzle the latter part of July for the second brood.

The spraying with these nozzles followed the usual practice of orchardists, the aim being to cover the entire tree, including the tips of the young apples, with a fine, misty spray.

Bordeaux nozzles. Plot 4. One application just after the blossoms fall; plot 5, the same as plot 4 but with a second spraying just before the calyx lobes close; plot 6, the same as plot 5 but with a third application with a Friend nozzle the last of July for the control of the second brood.

The nozzles were set so as to give a maximum of rather coarse spray which would not break up into fine spray until about 6 feet from the nozzle. The aim of the application was to drive the poison straight down into the tip of every young apple, the nozzle being held about 18 to 24 inches from the fruit so far as possible. The pressure was maintained at about 150 pounds.

Location and treatment of plots. The above series of experiments were conducted in a young orchard belonging to Mr W. H. Hart of Arlington, N. Y. near Poughkeepsie and located close to Briggs Station on the Hopewell branch of the Central New England Railroad. The orchard is on a moderately high hill, the trees being thrifty, about 15 years old, 15 to 18 feet high and 30 feet apart. The actual experimental trees were Baldwins though some of the barrier trees were Northern Spy. Each plot consists of approximately 42 trees, 6 trees in a row one way and 7 in a row the other way, the central 6 being the actual experimental trees. These latter were carefully selected for uniformity in size, fruitage and infestation. An examination of one tree resulted in finding 13 empty codling moth cells and in another none. These were not in experimental areas. The orchard as a whole had not been sprayed much prior to this year. A road runs along the

southern edge of the orchard and at the southeast corner there is an old orchard which was pastured all last summer and is probably not a serious disturbing factor so far as infestation by codling moth is concerned.

Plots 2 and 3 were located on two rows of Baldwins near the top of a hill, Northern Spys lying on either side and being used as east and west barrier trees. Plot 2 consists of 6 very uniform trees. Plot 3 was farther north on the same row and included, among the experimental trees, two which were not up to standard so far as fruiting or size is concerned. These two were not considered, the estimates being restricted to the 6 satisfactory ones. The experimental trees of plot 1 were remarkably vigorous and heavily fruited. Plot 4 was in the southeast portion of the experimental area next the old orchard mentioned above [*see* pl. 3]. Plot 5 was just west and a little north of plot 4, lying very nearly between the latter and plot 2. Plot 6 was just north of plot 5. Plots 5 and 6 have two rows of Spys as barriers on the west. The latter plot, namely 6, has also two rows of Spys as barriers on the north. Two check trees, x and y were near the northwest corner of plot 4 [*see* pl. 3]. Plot 1 was northeast of the check trees.

First application, May 20. Plots 5 and 6 were sprayed with the Bordeaux nozzles, one on each line of hose. The western experimental trees of both plots 5 and 6 were treated perhaps a little more thoroughly than the eastern trees of the said plots. Plot 4 had the experimental trees only sprayed with Bordeaux nozzles, Friend nozzles being used on the barrier trees. Plot 1 was sprayed throughout May 20 with Friend nozzles, plots 2 and 3 were similarly sprayed May 21 between 11 a. m. and 3.15 p. m., plot 3 being sprayed last and completed about 1 hour before it began to rain. The Bordeaux nozzle, with a pressure of 150 pounds, gave a stiff, penetrating spray which repeatedly passed the stamens and collected in the lower cavity. This was true, not only of blossoms where the stamens had withered somewhat, but also of those still bearing petals. The first two experimental trees next the road were sprayed with 125 to 150 pounds pressure and all the barrier trees, the remainder of the experimental trees in plot 2 and all of the experimental trees in plot 3 were sprayed with a pressure of 145 to 150 pounds. There was a perceptible difference in the penetration of the calyx cup, the higher pressure being the more satisfactory, there

being in some instances a collection of spray at the bottom of the calyx cup in the latter case. All of the spraying was from the ground, the hose being tied to poles and the nozzles set at an angle so as to discharge almost directly into all the blossoms, except possibly a very few on the highest branches. The defect with the Bordeaux nozzle employed was that the spray was not sufficiently spread out to permit of a very desirable rapidity in operation. It was exceedingly difficult, with the nozzles used, to be certain of hitting every apple. It was, however, markedly penetrating, throwing a rather coarse, forcible stream 6 or 8 feet and usually hitting the limbs near the center of the tree with considerable force.

The Friend nozzle gave a very well distributed, moderately fine mist spray which lacked the penetration of the coarser Bordeaux spray. In a few instances minute drops of spray were observed just within the stamens but there was never any collection of moisture at the bottom of the cup, seen in the case of flowers sprayed with the Bordeaux nozzle. The spray from the Friend nozzle with 125 pounds pressure is so fine that it rarely collects or runs at least upon the floral organs and can usually be seen as minute globules adhering to various parts of the leaf and foliage.

Applications. 5¼ pounds of Grasselli's arsenate of lead, and 10 pounds of copper sulfate were used to each 150 gallons of spray, enough lime being added to neutralize the copper sulfate as determined by the ferrocyanide test. 140 gallons of this mixture, using one Bordeaux nozzle on each line of hose, sufficed to treat 56 trees. It required about 1 minute to spray a tree 15 feet high with 1 lead of hose. 150 gallons of the spray were applied to 55 trees with 2 leads of hose, 2 Friend nozzles on each. It likewise required about 1 minute to spray a tree. The pressure while spraying with the 2 Bordeaux nozzles was kept at about 150 pounds. The pressure with the 4 Friend nozzles was maintained at about 125 pounds.

The weather was almost ideal for spraying on the 20th, there being very little wind until in the late afternoon. The 21st the weather was cloudy, wind strong and fitful. About 90% of the blossoms had dropped from the Baldwins at the time of application.

Second application, May 31. The calyx lobes were still widely expanded though the stamens and the tip of the pistil had shriveled and in many cases adhered so as to form an almost impassable barrier even to the heavy spray from the Bordeaux

nozzles. Repeated examinations failed to show a satisfactory penetration by either type of nozzle though 145 or even 150 pounds pressure was employed. This condition was observed, despite the fact that the calyx lobes for the most part showed no signs of closing and were mostly turned back. This phenomena was particularly apparent in the swelling fruit which had evidently been fertilized and was not so evident in the case of smaller apples doomed to shrivel and fall. The stamen bars of the latter were more widely separated and therefore more easily penetrated by the insecticide.

The weather was fair, warm and with a light to rather stiff breeze, the latter being more prevalent in the afternoon. The pressure varied from 120 to 145 pounds. Adler's arsenate of lead was employed instead of the Grasselli applied earlier, simply because the stock of the latter had been exhausted. Two Friend nozzles passed 4 gallons of spray mixture in 1 minute and 10 seconds at 150 to 160 pounds pressure, while 1 Bordeaux nozzle with 150 pounds pressure took about 1 minute and 15 to 20 seconds to discharge the same amount of insecticide. The pressure while the Bordeaux nozzles were in use, varied from 125 to 145 pounds. The penetration was distinctly less than 10 days previously. The eastern experimental trees were covered fully as thoroughly as the western ones in each of the plots. Plots 2 and 3 and 5 and 6 were sprayed, 2 and 3 with the new type Friend nozzles and 5 and 6 with the Bordeaux nozzles.

Third application, July 28. Experimental plots 3 and 6 were sprayed for the third time, using 2 pounds of Adler's arsenate of lead to 50 gallons of water and bordeaux mixture made with 4 pounds of copper sulfate to 50 gallons of water, enough lime being added to satisfy the ferrocyanide test. The weather was warm, clear and with very little or no wind. 75 gallons were used on the 48 trees of plot 4 and nearly as much on the 48 trees of plot 6.

General observations. Several weeks after spraying, the check trees were plainly more wormy than those in the adjacent plots; the fruit as a whole was in excellent condition, the apples being from 1 inch to 1½ inches in diameter. Some of the trees had suffered from aphis attack and a portion of the fruit was more or less deformed. Generally speaking, the fruit conditions throughout the experimental plots were uniform, though some trees will bear much more fruit than others. The experimental trees on plot 4 showed considerable yellowing of the foliage,

which Mr Hart thought might be due to bordeaux injury, induced to some extent possibly by dry weather. This yellowing was much more evident on the experimental trees of this plot than on the trees in the adjacent plot 3.

Under date of June 17 Mr Hart reports a very satisfactory growth of fruit though aphids increased rapidly. The first week in June the infestation was restricted almost exclusively to the fruiting trees, and started upon the whorls of leaves under fruit spurs. There was the usual stunting and malformation of the fruit. He found that the infestation was more severe on the 4 lower experimental plots than in other portions of the orchard. July 13 he states that the aphids had almost completely disappeared and while they affected the uniformity of the setting, there was still much good fruit. The orchard, including the experimental portion, was plowed in June, fertilized broadcast with 600 pounds per acre of a fertilizer made up of 400 pounds of ground bone, 100 pounds of 2–9–6 fertilizer and 100 pounds of sulfate of potash. It was harrowed several times and seeded on the 6th with large and crimson clover and cow horn turnips. He saw at this time a little codling moth work but not as much as last year. September 9th he states that the trees sprayed the third time had lost much of their foliage. The Baldwins apparently lost half of their leaves and the Spys over half [pl. 8, fig. 2], due probably to the bordeaux mixture and not to the poison. The remaining foliage appears healthy and the fruit is growing. A larger proportion of the foliage was shed on the upper plots than on the lower ones, especially on the Baldwins. The leaves of the latter turned yellow and dropped, while those of the Spys dropped without discoloring.

Experimental data

The following tables give the records for the individual trees. Some 100,000 apples were carefully handled one by one and classified, as will be seen by reference to the following data. September 13 and 14 the dropped apples under all the trees were carefully gathered and later, October 5 to 7, the remaining fruit was picked and classified. It will be seen by reference to the detailed tables, that the dropped fruit from the various sprayed plots gave from 14.91 to 26.67% of wormy fruit, while the two check trees had 73.91 and 81.02%, respectively, of wormy fruit. These figures are mostly interesting because they show what a large percentage of the wormy fruit drops before picking time.

Plot I (Sprayed once)

	Tree	Date	Total fruit	CLEAN FRUIT							WORMY FRUIT						
				Total	%	MARKETABLE FRUIT			SMALL FRUIT		Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
						Total	%	bbls.	Total	%							
	A	Sept. 13–14	79	72	91.14	.....	.....	.....	.....	.....	7	8.86	.....	.....	7	3	.....
		Oct. 5–7	4 970	4 866	97.88	2 973	59.80	2.75	1 893	38.08	104	2.12	6	6	92	74	6
Totals and %	.....	.....	5 049	4 938	97.77	2 973	58.87	.....	1 893	37.50	111	2.23	6	6	99	77	6
	B	Sept. 13–14	92	88	95.65	.....	.....	.....	.....	.....	4	4.35	.....	.....	4	2	.....
		Oct. 5–7	5 217	5 179	99.29	2 993	57.38	2.875	2 186	41.90	38	.72	3	1	34	20	7
Totals and %	.....	.....	5 309	5 267	99.23	2 993	56.38	.....	2 186	41.18	42	.77	3	1	38	22	7
	C	Sept. 13–14	86	80	93.02	.....	.....	.....	.....	.....	6	6.98	2	.....	4	2	.....
		Oct. 5–7	3 721	3 696	99.32	2 276	61.16	2.80	1 420	38.16	35	.68	5	.....	30	23	7
Totals and %	.....	.....	3 807	3 776	98.92	2 276	59.62	.....	1 420	37.20	41	1.08	7	.....	34	25	7
	D	Sept. 13–14	186	175	94.08	.....	.....	.....	.....	.....	11	6.92	5	1	5	7	.....
		Oct. 5–7	8 559	8 514	99.48	3 739	43.69	3.5	4 775	55.79	45	.52	3	3	39	29	4
Totals and %	.....	.....	8 745	8 689	99.37	3 739	42.76	.....	4 775	54.60	56	.63	8	4	44	36	4
	E	Sept. 13–14	47	40	85.10	.....	.....	.....	.....	.....	7	14.90	.....	.....	7	7	.....
		Oct. 5–7	2 460	2 388	97.11	1 375	55.89	1.8	1 013	41.17	72	2.94	8	6	58	39	4
Totals and %	.....	.....	2 507	2 428	96.84	1 375	54.84	.....	1 013	40.40	79	3.16	8	6	65	46	4
	F	Sept. 13–14	88	78	88.63	.....	.....	.....	.....	.....	10	11.37	.....	.....	10	6	.....
		Oct. 5–7	4 662	4 642	99.59	2 465	52.87	2.5	2 177	46.69	20	.44	1	1	18	10	2
Totals and %	.....	.....	4 750	4 720	99.36	2 465	51.89	.....	2 177	45.84	30	.64	1	1	28	16	2
Grand totals and % for plot	.....	.....	30 167	29 818	98.8	15 821	.....	.....	13 464	44.61	359	1.19	.....	.....	.....	.....	.....

Plot 2 (Sprayed twice)

	Tree	Date	Total fruit	CLEAN FRUIT							WORMY FRUIT						
						MARKETABLE FRUIT			SMALL FRUIT								
				Total	%	Total	%	bbls.	Total	%	Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
	A	Sept. 13–14	29	28	96.55	.....	.....	.....	.....	.....	1	3.45	.....	.....	1	1	.....
		Oct. 5–7	2 142	2 127	99.29	1 227	57.28	1.75	900	42.01	15	.70	1	.....	14	11	.....
Totals and %	.....	.....	2 171	2 155	99.26	1 227	56.51	.....	900	41.45	16	.74	1	.....	15	12	.....
	B	Sept. 13–14	48	38	79.16	.....	.....	.....	.....	.....	10	20.84	.....	1	9	9	.....
		Oct. 5–7	1 574	1 554	98.72	1 095	69.57	1.125	459	29.10	20	1.28	1	.....	19	14	.....
Totals and %	.....	.....	1 622	1 592	98.15	1 095	67.50	.....	459	28.29	30	1.85	1	1	28	23	.....
	C	Sept. 13–14	5	5	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
		Oct. 5–7	221	215	97.28	155	70.13	.2	60	27.14	6	2.72	.....	1	5	1	.....
Totals and %	.....	.....	226	220	97.34	155	68.58	.....	60	26.54	6	2.66	.....	1	5	1	.....
	D	Sept. 13–14	11	10	90.90	.....	.....	.....	.....	.....	1	9.10	.....	1	.....	.....	.....
		Oct. 5–7	1 468	1 460	99.45	1 044	71.11	1.3	416	28.34	8	.55	.....	.....	8	7	.....
Totals and %	.....	.....	1 479	1 470	99.39	1 044	70.58	.....	416	28.12	9	.61	.....	1	8	7	.....
	E	Sept. 13–14	27	25	92.59	.....	.....	.....	.....	.....	2	7.41	.....	1	1	2	.....
		Oct. 5–7	3 622	3 597	99.30	2 026	55.93	1.8	1 571	43.37	25	.70	1	3	21	13	3
Totals and %	.....	.....	3 649	3 622	99.25	2 026	55.52	.....	1 571	43.04	27	.75	1	4	22	15	3
	F	Sept. 13–14	18	14	77.77	.....	.....	.....	.....	.....	4	22.23	.....	.....	4	4	.....
		Oct. 5–7	1 151	1 133	98.43	877	76.19	1.4	256	22.24	18	1.57	1	.....	17	12	2
Totals and %	.....	.....	1 169	1 147	98.11	877	75.02	.....	256	21.89	22	1.89	1	.....	21	16	2
Grand totals and % for plot	.....	.....	10 316	10 206	98.93	6 424	62.27	.....	3 662	35.49	110	1.07	.....	.....	.....	.....	.....

Plot 3 (Sprayed three times)

	Tree	Date	Total fruit	CLEAN FRUIT							WORMY FRUIT						
				Total	%	MARKETABLE FRUIT			SMALL FRUIT		Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
						Total	%	bbls.	Total	%							
	A	Sept. 13–14	97	87	89.69	.....	.....	.....	.....	.....	10	10.31	.....	2	8	8	2
		Oct. 5–7	2 101	2 082	99.09	1 470	69.96	1.9	612	29.12	19	.91	2	2	15	12	.....
Totals and %	.....	.....	2 198	2 169	98.68	1 470	66.87	.....	612	27.84	29	1.32	2	4	23	20	2
	B	Sept. 13–14	25	18	72	.....	.....	.....	.....	.....	7	18	.....	1	6	6	.....
		Oct. 5–7	392	388	98.97	324	82.65	.6	64	16.32	4	1.03	.....	1	3	2	.....
Totals and %	.....	.....	417	406	97.36	324	77.69	.....	64	15.34	11	2.64	.....	2	9	8	.....
	C	Sept. 13–14	59	52	88.13	.....	.....	.....	.....	.....	7	11.87	.....	1	6	5	.....
		Oct. 5–7	2 006	1 985	98.95	1 039	51.74	1.1	946	47.15	21	1.05	3	1	17	14	1
Totals and %	.....	.....	2 065	2 037	98.64	1 039	50.32	.....	946	45.81	28	1.36	3	2	23	19	1
	D	Sept. 13–14	40	38	95	.....	.....	.....	.....	.....	2	5	.....	.....	2	2	.....
		Oct. 5–7	1 220	1 218	99.83	762	62.45	.85	456	37.37	2	.17	.....	.....	2	1	.....
Totals and %	.....	.....	1 260	1 256	99.68	762	60.47	.....	456	36.19	4	.32	.....	.....	4	3	.....
	E	Sept. 13–14	41	35	85.36	.....	.....	.....	.....	.....	6	14.64	.....	.....	6	4	1
		Oct. 5–7	1 401	1 395	99.57	945	67.52	1.1	450	32.05	6	.43	.....	1	5	6	.....
Totals and %	.....	.....	1 442	1 430	99.16	945	65.53	.....	450	31.20	12	.84	.....	1	11	10	1
	F	Sept. 13–14	158	151	95.56	.....	.....	.....	.....	.....	7	4.44	2	.....	5	4	.....
		Oct. 5–7	2 140	2 133	99.67	1 505	70.32	2	628	29.34	7	.33	1	1	5	3	1
Totals and %	.....	.....	2 298	2 284	99.39	1 505	65.49	.....	628	27.32	14	.61	3	1	10	7	1
Grand totals and % for plot	.....	.....	9 680	9 582	98.99	6 045	62.44	.....	3 156	32.60	98	1.01	.....	.....	.....	.....	.....

Plot 4 (Sprayed once)

	Tree	Date	Total fruit	CLEAN FRUIT							WORMY FRUIT						
				Total	%	MARKETABLE FRUIT			SMALL FRUIT		Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
						Total	%	bbls.	Total	%							
	A	Sept. 13–14	58	44	75.86	.....	.....	.....	.....	.....	14	24.14	2	.....	12	11	.....
		Oct. 5–7	2 944	2 878	97.79	1 661	56.43	2	1 217	41.01	66	2.21	6	.....	60	40	3
Totals and %			3 002	2 922	97.36	1 661	55.34	.....	1 217	40.55	80	2.64	8	.....	72	51	3
	B	Sept. 13–14	74	66	89.18	.....	.....	.....	.....	.....	8	10.82	.....	.....	8	2	1
		Oct. 5–7	3 387	3 347	98.81	1 560	46.05	1.5	1 787	52.76	40	1.19	5	.....	35	27	3
Totals and %			3 461	3 413	98.61	1 560	45.07	.....	1 787	51.63	48	1.39	5	.....	43	29	4
	C	Sept. 13–14	137	130	94.89	.....	.....	.....	.....	.....	7	5.11	.....	.....	7	2	.....
		Oct. 5–7	2 917	2 888	99.03	1 695	58.12	2	1 193	40.91	29	.97	2	1	26	21	1
Totals and %			3 054	3 018	98.85	1 695	55.53	.....	1 193	39.07	36	1.15	2	1	33	23	1
	D	Sept. 13–14	95	88	92.63	.....	.....	.....	.....	.....	7	7.37	1	.....	6	3	.....
		Oct. 5–7	3 941	3 901	98.98	1 917	48.64	1.9	1 984	50.34	40	1.01	7	1	32	24	2
Totals and %			4 036	3 989	98.84	1 917	47.49	.....	1 984	49.16	47	1.16	8	1	38	27	2
	E	Sept. 13–14	54	48	88.88	.....	.....	.....	.....	.....	6	11.12	1	1	4	2	.....
		Oct. 5–7	1 662	1 631	98.13	982	59.08	.9	649	39.04	31	1.87	3	.....	28	18	3
Totals and %			1 716	1 679	98.42	982	57.21	.....	649	37.82	37	1.58	4	1	32	20	3
	F	Sept. 13–14	33	26	78.78	.....	.....	.....	.....	.....	7	21.22	2	1	4	3	.....
		Oct. 5–7	5 011	4 970	99.18	2 244	44.78	2	2 726	54.40	41	.82	2	2	37	24	8
Totals and %			5 044	4 996	99.04	2 244	44.49	.....	2 726	54.04	48	.96	4	3	41	27	8
Grand totals and % for plot			20 313	20 017	98.55	10 059	49.30	.....	9 556	46.84	296	1.45	.....	.....	.....	.....	.....

Plot 5 (Sprayed twice)

	Tree	Date	Total fruit	CLEAN FRUIT							WORMY FRUIT						
				Total	%	MARKETABLE FRUIT			SMALL FRUIT		Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
						Total	%	bbls.	Total	%							
	A	Sept. 13–14	27	25	92.59	.....	.....	.....	.....	.....	2	7.41	.....	1	1	2	.....
		Oct. 5–7	967	954	98.65	741	76.62	1.2	213	22.02	13	1.35	1	1	11	5	.....
Totals and %	.....	.....	994	979	98.50	741	74.63	.....	213	21.42	15	1.50	1	2	12	7	.....
	B	Sept. 13–14	69	61	88.40	.....	.....	.....	.....	.....	8	11.60	1	.....	7	2	.....
		Oct. 5–7	3 195	3 157	98.81	2 284	71.48	2.5	873	27.32	38	1.19	3	1	34	24	8
Totals and %	.....	.....	3 264	3 218	98.59	2 284	69.97	.....	873	26.75	46	1.41	4	1	41	26	8
	C	Sept. 13–14	23	19	82.60	.....	.....	.....	.....	.....	4	17.40	.....	1	3	1	.....
		Oct. 5–7	3 337	3 316	99.37	1 543	46.20	1.3	1 773	53.13	21	.63	.....	.....	21	12	1
Totals and %	.....	.....	3 360	3 335	99.25	1 543	45.92	.....	1 773	52.76	25	.75	.....	1	24	13	1
	D	Sept. 13–14	27	23	85.18	.....	.....	.....	.....	.....	4	14.82	.....	.....	4	3	.....
		Oct. 5–7	5 110	5 089	99.66	2 355	46.12	2	2 734	53.54	21	.44	2	.....	19	16	2
Totals and %	.....	.....	5 137	5 112	99.51	2 355	45.88	.....	2 734	53.26	25	.49	2	.....	23	19	2
	E	Sept. 13–14	26	22	84.61	.....	.....	.....	.....	.....	4	15.39	.....	.....	4	3	.....
		Oct. 5–7	3 828	3 771	98.56	2 271	59.35	2.4	1 500	39.22	57	1.44	2	4	51	45	5
Totals and %	.....	.....	3 854	3 793	98.49	2 271	58.95	.....	1 500	38.94	61	1.51	2	4	55	48	5
	F	Sept. 13–14	42	37	88.09	.....	.....	.....	.....	.....	5	11.91	.....	.....	5	4	.....
		Oct. 5–7	2 624	2 610	99.50	1 228	46.81	2	1 382	52.68	14	.50	1	1	12	9	2
Totals and %	.....	.....	2 666	2 647	99.32	1 228	46.07	.....	1 382	51.85	19	.68	1	1	17	13	2
Grand totals and % for plot	.....	.....	19 275	19 084	99.01	10 422	54.08	.....	8 475	43.98	191	.99	.....	.....	.....	.....	.....

Plot 6 (Sprayed three times)

	Tree	Date	Total fruit	CLEAN FRUIT						WORMY FRUIT						
				Total	%	MARKETABLE FRUIT			SMALL FRUIT		Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
						Total	%	bbls.	Total	%							
	A	Sept. 13–14	15	11	73.33	.....	.....	.....	.....	.....	4	26.67	1	.....	3	4	.....
		Oct. 5–7	752	735	97.73	495	65.82	.4	240	31.91	17	2.27	.....	.....	17	12	2
Totals and %	.....	.....	767	746	97.26	495	64.53	.....	240	31.29	21	2.74	1	.....	20	16	2
	B	Sept. 13–14	33	29	87.87	.....	.....	.....	.....	.....	4	12.13	.....	1	3	2	.....
		Oct. 5–7	629	626	99.52	353	56.12	.8	273	43.40	3	.48	.....	1	2	2	1
Totals and %	.....	.....	662	655	98.94	353	53.32	.....	273	41.23	7	1.06	.....	2	5	4	1
	C	Sept. 13–14	21	20	95.23	.....	.....	.....	.....	.....	1	4.77	.....	.....	1	1	.....
		Oct. 5–7	1 340	1 334	99.53	889	66.34	.7	445	33.20	6	.47	.....	.....	6	6	.....
Totals and %	.....	.....	1 361	1 354	99.48	889	65.31	.....	445	32.69	7	1.25	.....	.....	7	7	.....
	D	Sept. 13–14	37	32	86.48	.....	.....	.....	.....	.....	5	13.52	1	.....	4	3	.....
		Oct. 5–7	876	866	98.85	452	51.59	.8	414	47.25	10	1.15	4	.....	6	3	1
Totals and %	.....	.....	913	898	98.35	452	49.50	.....	414	45.34	15	1.87	5	.....	10	6	1
	E	Sept. 13–14	97	93	95.87	.....	.....	.....	.....	.....	4	4.13	.....	.....	4	2	.....
		Oct. 5–7	3 224	3 205	99.41	2 320	71.96	2	885	27.45	19	.59	.....	1	18	18	.....
Totals and %	.....	.....	3 321	3 298	99.30	2 320	69.85	.....	885	26.64	23	.70	.....	1	22	20	.....
	F	Sept. 13–14	16	12	75	.....	.....	.....	.....	.....	4	25	.....	.....	4	3	.....
		Oct. 5–7	670	670	100	417	62.23	.....	253	37.76	.....	.....	.....	.....	.....	.....	.....
Totals and %	.....	.....	686	682	99.41	417	60.78	.....	253	36.87	4	.59	.....	.....	4	3	.....
Grand totals and % for plot	.....	.....	7 710	7 633	99	4 926	63.89	.....	2 510	32.55	77	1	.....	.....	.....	.....	.....

Check trees (Unsprayed)

	Tree	Date	Total fruit	CLEAN FRUIT							WORMY FRUIT						
				Total	%	MARKETABLE FRUIT			SMALL FRUIT		Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
						Total	%	bbls.	Total	%							
	X	Sept. 13–14	216	41	18.98	.....	.....	.....	.....	.....	175	81.02	57	69	49	114	10
		Oct. 5–7	2 389	1 896	79.29	923	38.60	.875	973	40.65	493	20.29	152	176	165	311	65
Totals and %	.....	.....	2 605	1 937	74.29	923	35.40	.....	973	37.32	668	25.71	209	245	214	425	75
	Y	Sept. 13–14	69	18	26.09	.....	.....	.....	.....	.....	51	73.91	27	19	5	24	2
		Oct. 5–7	577	411	71.23	225	38.99	.375	186	32.23	166	28.77	76	38	52	101	6
Totals and %	.....	.....	646	429	66.43	225	34.82	.....	186	28.77	217	33.57	103	57	57	125	8
Grand totals and % for plot	.....	.....	3 251	2 366	72.73	1 148	35.29	.....	1 159	35.62	885	27.27	.....	.....	.....	.....	.....

Summary of plots

PLOT	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT			
		No.	%	No.	%	Range of % between trees	Range in no. between trees
1	30 177	29 818	98.81	359	1.19	.63 — 3.16	30 — 111
2	10 316	10 206	98.93	110	1.07	.61 — 2.66	6 — 30
3	9 680	9 582	98.99	98	1.01	.32 — 2.64	4 — 29
4	20 313	20 017	98.55	296	1.45	.96 — 2.64	36 — 80
5	19 275	19 084	99.01	191	.99	.49 — 1.51	15 — 61
6	7 710	7 633	99	77	1	.59 — 2.74	4 — 23
Check	3 251	2 366	72.73	885	27.27	25.71 — 33.57	217 — 668

It will be observed that in these tables we have separated the small fruit, the product largely of severe aphis injury. The significance of this data is discussed on page 75. It was incidental to the major investigation and has very little or no influence on the codling moth problem, aside from a probably slight reduction in the percentage of wormy fruit. A study of the results as a whole, is extremely interesting. It will be seen by reference to the table giving the summaries for each plot, that the three sprayed with a Friend nozzle, produced from 98.81 to 98.99% of worm-free fruit, the higher percentage being obtained on the plot receiving three applications. In a like manner, the three treated with a Bordeaux nozzle, yielded 98.55 to 99% of worm-free fruit, the slightly higher percentage, as in the preceding group, being obtained on the plot receiving three applications. This apparent lack of material benefit resulting from the second and third application, may be due in slight measure to the fact that the plots sprayed but once produced more apples than those receiving the second and third sprayings, though the difference is not uniform and the variation between the percentage of worm-free fruit does not coincide exactly with the difference in yield between the various plots. For example, between plots 2 and 3 there is a difference of only 636 apples out of approximately 10,000, a variation hardly large enough to materially influence the percentage of worm-free fruit. This latter is only .06 of 1% in favor of the trees receiving three applications. Similarly, on plots 4 and 5 there is a variation of but 1030 out of approximately 10,000 and a difference in the percentage of worm-free fruit of but .46% in favor of the trees sprayed twice. It can hardly be claimed, in view of

these figures, that the variation in the yield on the various plots has affected materially the results obtained, though there is a somewhat uniform though accidental (owing to the yield of the various plots) decrease in production with an increase in the number of poison applications.

The material benefits resulting from the application of poisons is well shown by our obtaining only about 72% of worm-free fruit on the check trees, while the sprayed plots produced from 98 to 99% of sound fruit. The observations upon the apples were checked by an examination of the trunks of the trees the following May. This showed that paper bands, accidentally left on check trees X and Y, sheltered numerous codling moth cocoons, there being some 60 on X and 50 on Y. Examination of bands on sprayed trees in other plots resulted in finding no codling moth larvae.

There is, it will be seen by reference to the detailed tabulations, and also the summary, more or less variation between the percentage of wormy fruit obtained from trees of the different plots. For example, in plots 1 to 3 this ranges from .32 of 1% to 3.16% or a difference of 4 to 111 wormy apples. On plots 4 to 6 we have a variation between individual trees, of .49 of 1% to 2.74% or a range of from 4 to 80 wormy apples. These variations can hardly be considered excessive if a moderate allowance is made for the difference normally obtaining in an orchard, and also for the difficulty of spraying every tree exactly alike.

Fruitfulness and infestation

PLOT	MAXIMUM TREE		MINIMUM TREE	
	No. fruit	% wormy	No. fruit	% wormy
1	8 745	.63	2 507	3.16
2	3 649	.75	226	2.66
3	2 298	.61	417	2.64
4	5 044	.96	3 002	2.64
5	5 137	.49	994	1.50
6	3 321	.70	767	2.74

A study of the results obtained on maximum and minimum trees, show that in plot 1, the maximum tree producing 8745 apples yielded but .63 of 1% wormy fruit, while the minimum tree producing 2507 apples had 3.16% wormy. Similar results, it will be seen by referring to the table showing the variation in individual trees, were found in the other plots. That these vari-

ations are mostly local and hardly of general application, is shown by a study of the figures for all the plots. There was, as pointed out previously, a remarkably uniform percentage of worm-free fruit throughout, despite the considerable variation in the product. The benefits of the second or third application must of necessity be restricted to reducing the 1 or 1½% of wormy fruit. It is hardly probable that equally good results could be obtained every year.

Summary of wormy fruit

PLOT	TOTAL FRUIT	RANGE OF TREES	END WORMY		END AND SIDE WORMY		TOTAL END WORMY		SIDE WORMY		EXIT HOLE 1		EXIT HOLE 2	
			Total	Range	Total	Range	No.	%	Total	Range	Total	Range	Total	Range
1	359	30–111	33	1– 8	18	0– 6	51	14.20	308	28– 99	222	16–77	30	2– 7
2	110	6– 30	4	0– 1	7	0– 4	11	10	99	5– 28	74	1– 23	5	0– 3
3	98	4– 29	8	0– 3	10	0– 4	18	18.36	80	4– 23	77	3– 29	5	0– 2
4	296	36– 80	31	2– 8	6	0– 3	37	12.50	259	32– 72	177	20– 51	21	1– 8
5	191	15– 61	10	0– 4	9	0– 4	19	9.94	172	12– 41	126	7– 48	18	0– 8
6	77	4– 23	6	0– 5	3	0– 2	9	11.68	68	4– 22	56	3– 20	4	0– 2
Check	885	217–668	312	103–209	302	57–245	614	69.37	271	57–214	550	125–425	83	8–75
FINE (PLOTS 1–3) CONTRASTED WITH COARSE (PLOTS 4–6) SPRAY														
1–3	567	.....	45	1–8	35	0–6	80	14	487	28–99	373	16–77	40	2–7
4–6	564	.....	47	2–8	18	0–3	65	11.50	499	32–72	359	20–51	43	1–8
Average	....	.....	....	.....	....	.....	....	12.82	....	.....	....	.....	....	.....

A study of the condition of the wormy fruit gives some interesting data as to the point of attack, though very little can be gleaned therefrom in favor of using a coarse spray with a heavy pressure, as compared with a finer spray and more moderate power. It will be seen by reference to the table above, that on plots 1 to 3, 10 to 18.36% of all the wormy apples were entered at the end, an average of 14% end wormy. Similarly, in the case of plots 4 to 6, the variation is from 9.94% to 12.50% or an average of 11.50% of end wormy apples in the total infested. Compare these percentages with the 69.37% end wormy of the infested apples on the two check trees. It will be seen at once that the major portion of the codling moth larvae destroyed, must have been killed in or about the blossom end because of the enormous reduction in the number of end wormy apples. A comparison between the percentages of the wormy apples entered at the end in plots 1 to 3 with those of plots 4 to 6, reveals, so far as this factor is concerned, a slight gain in favor of the coarse, heavy spray of the Bordeaux nozzle. On the other hand, comparisons between the totals for plots 1 to 3 and 4 to 6 respectively, show that the first produced 50,173 apples of which 98.87% were free from infestation, while the latter yielded 47,298 apples and had 98.81% of worm-free fruit, a difference of only .06 of 1% in favor of the finer spray. A comparison of the totals of the wormy fruit between these two series of plots given in the above table shows an equally close parallelism.

Experiments 1 and 4 were duplicated in the orchard of Edward Van Alstyne at Kinderhook, N. Y., the plots being located as shown on plate 4. In addition, a third plot designated as 7, was sprayed for the purpose of testing the results to be obtained from a still higher pressure, and an attempt was made to keep the gage up to 200 pounds. Plot 4, located near the barn, consisted of Greenings; plots 1 and 7 were Baldwins, the latter being seven rows north of the barn, on a knoll and a little to the east of the other plots, while the two check trees lay near the northern boundary of plot 1. Spraying began May 29. The weather was cloudy, threatening and with a little wind. There was a heavy shower from 1 to about 1.30 p. m. and another at 2 p. m. resulting in a cessation of operations.

The spraying May 29 was with the old type of Friend nozzle, which is considerably deeper than the latter make. The pressure

was maintained at 100 pounds; 4 pounds of Grasselli's arsenate of lead and 3 pounds of copper sulfate with lime enough to satisfy the ferrocyanide test was employed for each 50 gallons of the mixture.

The calyx lobes were mostly well turned back and all the petals were off; the pollen cells had begun to brown though there was no wilting of the stamen bars.

Owing to interruptions by rain noted above, but five experimental trees of plot 4 were sprayed, the northwestern one not being treated. The three southernmost rows of plot 4 were sprayed mostly from the north side, except the barrier trees on the west end of row 3 counting from the barn. Observations showed that the experimental trees in particular were very well covered with the poison.

Spraying was continued June 2, plot 4 being completed in the morning. The experimental trees of plot 1 were sprayed at 100 pounds pressure. There was practically no penetration to the inner calyx cavity. The tips of the pistils and stamens were dead and the calyx lobes partially closed. The afternoon was fair with a light breeze.

Plot 7 was sprayed June 3 with a pressure of 150–60 pounds, though tree 7 E had its western side sprayed when there was a very low pressure owing to clogging of the pump. The pressure was not constant and much of the time the nozzles were held too far away to give the best results, a fact strikingly illustrated by the condition of the fruit at picking time.

Plot 1 (Sprayed once)

	Tree	Date	Total fruit	CLEAN FRUIT						WORMY FRUIT						
				Total	%	MARKETABLE FRUIT		SMALL FRUIT		Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
						Total	%	Total	%							
	A	Sept. 17–18	101	91	90.09	.....	.....	.....	.....	10	9.91	2	3	5	10	.....
		Oct. 12–13	2 445	2 417	98.85	2 269	92.8	148	6.05	28	1.15	1	1	26	18	2
Totals and %			2 546	2 508	98.51	2 269	89.12	148	5.81	38	1.49	3	4	31	28	2
	B	Sept. 17–18	198	189	95.49	.....	.....	.....	.....	9	4.51	2	1	6	6	1
		Oct. 12–13	3 017	3 001	99.46	2 846	94.33	155	5.13	16	.54	2	.....	14	10	.....
Totals and %			3 215	3 190	99.22	2 846	88.52	155	4.82	25	.78	4	1	20	16	1
	C	Sept. 17–18	143	142	99.30	.....	.....	.....	.....	1	.70	.....	.....	1	1	.....
		Oct. 12–13	1 877	1 863	99.25	1 813	96.05	50	2.66	14	.75	1	.....	13	9	2
Totals and %			2 020	2 005	99.25	1 813	89.75	50	2.47	15	.75	1	.....	14	10	2
	D	Sept. 17–18	310	293	94.51	.....	.....	.....	.....	17	5.49	3	2	12	11	.....
		Oct. 12–13	5 118	5 082	99.30	4 756	92.92	326	6.36	36	.70	6	2	28	16	3
Totals and %			5 428	5 375	99.02	4 756	87.61	326	6.00	53	.98	9	4	40	27	3
	E	Sept. 17–18	234	215	91.88	.....	.....	.....	.....	19	8.12	1	4	14	15	1
		Oct. 12–13	3 364	3 330	98.99	3 095	92.06	235	7.04	34	1.01	3	2	29	21	.....
Totals and %			3 598	3 545	98.55	3 095	86.02	235	6.53	53	1.45	4	6	43	36	1
	F	Sept. 17–18	161	153	95.03	.....	.....	.....	.....	8	4.97	1	3	4	7	1
		Oct. 12–13	4 296	4 266	99.30	4 046	94.18	220	5.12	30	.70	1	.....	29	20	4
Totals and %			4 457	4 419	99.14	4 046	90.77	220	4.93	38	.86	2	3	33	27	5
Grand totals and % for plot			21 264	21 042	98.96	18 825	88.52	1 134	5.33	222	1.04	.....	.....	.....	.....	.....

Plot 4 (Sprayed once)

	Tree	Date	Total fruit	CLEAN FRUIT						WORMY FRUIT						
				Total	%	MARKETABLE FRUIT		SMALL FRUIT		Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
						Total	%	Total	%							
	A	Sept. 17–18	115	109	94.78	.....	.....	.....	.....	6	5.12	.....	.....	6	5	.....
		Oct. 12–13	1 122	1 105	98.57	905	80.66	200	17.82	17	1.43	.....	.....	17	7	2
Totals and %	.....	.....	1 237	1 214	98.14	905	73.16	200	16.16	23	1.86	.....	.....	23	12	2
	B	Sept. 17–18	143	129	90.20	.....	.....	.....	.....	14	9.80	1	4	9	12	.....
		Oct. 12–13	2 380	2 313	97.18	1 578	66.30	735	30.88	67	2.82	8	5	54	28	11
Totals and %	.....	.....	2 523	2 442	96.78	1 578	62.54	735	29.12	81	3.22	9	9	63	40	11
	C	Sept. 17–18	147	142	96.59	.....	.....	.....	.....	5	3.41	1	1	3	3	.....
		Oct. 12–13	1 366	1 350	98.75	960	70.22	390	28.52	16	1.25	4	.....	12	4	2
Totals and %	.....	.....	1 513	1 492	98.54	960	63.40	390	25.75	21	1.46	5	1	15	7	2
	D	Sept. 17–18	134	134	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
		Oct. 12–13	1 400	1 389	99.21	1 175	83.92	214	15.28	11	.79	.....	2	9	6	1
Totals and %	.....	.....	1 534	1 523	99.28	1 175	76.59	214	13.95	11	.72	.....	2	9	6	1
	E	Sept. 17–18	126	123	97.61	.....	.....	.....	.....	3	2.39	.....	.....	3	3	.....
		Oct. 12–13	1 038	1 031	99.32	810	78.03	221	21.29	7	.68	1	.....	6	2	2
Totals and %	.....	.....	1 164	1 154	99.14	810	69.58	221	18.98	10	.86	1	.....	9	5	2
	F	Sept. 17–18	191	187	97.85	.....	.....	.....	.....	4	2.15	1	1	2	4	.....
		Oct. 12–13	1 690	1 671	98.87	1 306	77.27	365	21.59	19	1.13	3	.....	16	9	1
Totals and %	.....	.....	1 881	1 858	98.77	.....	69.43	365	19.40	23	1.23	4	1	18	13	1
Grand totals and % for plot	.....	.....	9 852	9 683	98.27	6 734	68.34	2 125	21.55	169	1.73	.....	.....	.....	.....	.....

Plot 7 (Sprayed once)

	Tree	Date	Total fruit	CLEAN FRUIT						WORMY FRUIT						
				Total	%	MARKETABLE FRUIT		SMALL FRUIT		Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
						Total	%	Total	%							
	A	Sept. 17–18	173	164	94.79	.....	.....	.....	.....	9	5.21	1	1	7	4	.....
		Oct. 12–13	3 205	3 167	98.81	3 059	95.44	108	3.36	38	1.19	.....	3	35	10	5
Totals and %			3 378	3 331	98.61	3 059	90.56	108	3.19	47	1.39	1	4	42	14	5
	B	Sept. 17–18	167	150	89.82	.....	.....	.....	.....	17	10.18	2	5	10	14	.....
		Oct. 12–13	1 621	1 585	97.77	1 498	91.79	87	5.98	36	2.23	1	2	33	14	1
Totals and %			1 788	1 735	97.03	1 498	83.78	87	4.90	53	2.97	3	7	43	28	1
	C	Sept. 17–18	234	217	92.73	.....	.....	.....	.....	17	7.27	2	1	14	12	1
		Oct. 12–13	2 515	2 455	97.61	2 034	80.87	421	16.73	60	2.39	2	2	56	33	2
Totals and %			2 749	2 672	97.23	2 034	73.99	421	15.31	77	2.77	4	3	70	45	3
	D	Sept. 17–18	135	122	90.37	.....	.....	.....	.....	13	9.63	.....	.....	13	12	.....
		Oct. 12–13	3 154	3 108	98.54	3 010	95.43	98	3.10	46	1.46	2	.....	44	25	5
Totals and %			3 289	3 230	98.20	3 010	91.52	98	2.98	59	1.80	2	.....	57	37	5
	E	Sept. 17–18	196	155	79.08	.....	.....	.....	.....	41	20.92	7	13	21	31	3
		Oct. 12–13	3 229	3 101	96.03	2 993	92.67	108	3.34	128	3.97	24	2	102	109	10
Totals and %			3 425	3 256	95.06	2 993	87.38	108	3.15	169	4.94	31	15	123	140	13
	F	Sept. 17–18	240	220	91.66	.....	.....	.....	.....	20	8.34	5	1	14	18	.....
		Oct. 12–13	4 222	4 173	98.83	3 907	74.81	266	6.30	49	1.17	5	2	42	32	1
Totals and %			4 462	4 393	98.45	3 907	87.56	266	5.96	69	1.55	10	3	56	50	1
Grand totals and % for plot			19 091	18 617	97.52	16 501	86.42	1 088	5.7	474	2.48	.....	.....	.....	.....	.....

Check trees (Unsprayed)

	Tree	Date	Total fruit	CLEAN FRUIT						WORMY FRUIT						
				Total	%	MARKETABLE FRUIT		SMALL FRUIT		Total	%	End wormy	End & side wormy	Side wormy	Exit hole 1	Exit hole 2
						Total	%	Total	%							
	X	Sept. 17–18	415	143	34.45	.....	.....	.....	.....	272	65.55	108	108	56	202	20
		Oct. 12–13	3 455	3 054	88.39	2 938	85.03	116	3.35	401	11.61	158	108	135	224	27
Totals and %			3 870	3 197	82.62	2 938	75.91	116	2.99	673	17.38	266	216	191	426	47
	Y	Sept. 17–18	637	114	17.89	.....	.....	.....	.....	523	82.11	189	202	132	410	27
		Oct. 12–13	2 508	1 816	72.40	1 737	69.25	79	3.14	692	27.60	219	212	261	371	91
Totals and %			3 145	1 930	61.36	1 737	55.23	79	2.51	1 215	38.64	408	414	393	781	118
Grand totals and % for plot			7 015	5 127	73.08	4 675	66.64	195	2.77	1 888	26.92	.....	.....	.....	.....	.....

Summary of plots

PLOT	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT		RANGE OF % VARIATION BETWEEN TREES
		No.	%	No.	%	
1	21 264	21 042	98.96	222	1.04	.75 — 1..49
4	9 852	9 683	98.27	169	1.73	.72 — 3.22
7	19 091	18 617	97.52	474	2.48	1.39 — 4.94
Check	7 015	5 127	73.08	1 888	26.92	17.38 — 38.64

Summary of wormy fruit

PLOT	TOTAL FRUIT	RANGE	END WORMY		END AND SIDE WORMY		TOTAL END WORMY		SIDE WORMY		EXIT HOLE 1		EXIT HOLE 2	
			Total	Range	Total	Range	No.	%	Total	Range	Total	Range	Total	Range
1	222	15–53	23	1–9	18	0–6	41	18.47	181	14–43	144	10–36	14	1– 5
4	169	10–81	19	0–9	13	0–9	32	18.90	137	9–63	83	5–40	19	1–11
7	474	47–169	51	1–31	32	0–15	83	17.51	391	42–123	314	14–140	28	1–13
Check	1 888	673–1215	674	266–408	630	216–414	1 304	69.21	584	191–393	1 207	426–781	165	47–118

It will be seen by referring to the above tables that the results obtained at Poughkeepsie were confirmed in large measure by those secured at Kinderhook, plots 1, 4 and 7, respectively, producing 98.96, 98.27 and 97.52% of worm-free fruit, while the two check trees yielded only 73.08% of clean fruit. These percentages, it will be observed, are slightly lower than those obtained at Poughkeepsie and may be explained by local conditions. The trees were larger and probably somewhat more infested by codling moth. The application was with a hand pump and, as a result, there was more difficulty in maintaining an even pressure. The slightly lower percentage obtained in plot 7 was not due to the higher, approximately 200 pounds pressure, but is undoubtedly explainable by a lack of thoroughness in application, since only 95.06% of clean fruit occurred on one tree where the application was not quite as thorough as it should have been. This obviously reduced the percentage for the entire plot materially. It will be seen in this series, as in the preceding, that a considerable proportion of the benefit results in destroying the codling moth larvae at or in the calyx end of the fruit, since in the sprayed plots 17.51 to 18.9% of the wormy fruit was entered at the end, while 69.21% of the wormy fruit on the check trees was thus infested. It will be noted that a considerably larger percentage of the fruit was end wormy at Kinderhook, compared to our findings at Poughkeepsie.

The data submitted above justifies the expectation that under normal conditions as they are found in the Hudson valley at least, one thorough application of a poison within a week or 10 days after the blossoms fall, should result in protecting a very large percentage, 98 to 99%, of the fruit from codling moth injury. We would emphasize the necessity of thorough work, though by this we do not mean an effort to drive the poison into the lower calyx cavity, desirable though this may be on theoretical grounds, but thoroughness in covering the foliage, the young fruit, in particular the blossom end, a point favored, as our investigations show, by about 69% of the worms entering the apple. We would select a nozzle giving the most uniform and rapid distribution of spray without regard to penetration. This should not be understood as discouraging the employment of high pressure, since this is undoubtedly an important factor in thorough and rapid work, the latter being extremely desirable on account of the limited time when successful applications may

be made. We are satisfied that most excellent results can be obtained where conditions permit the employment of only moderate pressures.

It should be understood that such results can hardly be obtained upon trees in the near vicinity of others which have not been sprayed. It will be seen by reference to the preceding account of the habits of this insect, that the codling moth may breed upon trees bearing no fruit, consequently, we believe it will pay the fruit grower to spray all trees in a bearing orchard without regard to whether they are fruiting or not. Our experience last year demonstrated the necessity of very thorough work if the high percentages of worm-free fruit cited above, are to be obtained. One tree in a special plot, where spraying was less thorough than on the others, though not perceptible to the eye of a practical orchardist making the application, produced only 95.06% of worm-free fruit. We would suggest that thoroughness in the distribution of the poison, in an effort to cover every portion of leaf and fruit with minute particles of spray will, in the long run, prove more effective and satisfactory than the application of large amounts of poison, especially if the spray is used so liberally as to cause dripping.

It may appear to some that the above results are too good even for an experiment, not to mention the practical fruit grower. The facts of the case are that all our sprayings were made by fruit growers with apparatus at hand. The scientist simply insisted on good, thorough work. The spraying was not nearly so heavy as it might have been and could not on that account be deemed impractical.

Work of other experimentors

There is abundant evidence to show that our general results with the sprays were not markedly superior to what others have been able to obtain, whether they were located in New Hampshire, West Virginia or some other portion of the country. This aspect of the problem therefore requires little discussion. On the other hand, the tests with but one spray have not been so numerous and were mostly conducted under conditions where error could not be easily eliminated. Experiments very similar to ours were those of Sanderson ['08]. In 1907 he sprayed a plot of six trees once, just after the blossoms fell, using 2 pounds of arsenate of lead to a barrel of bordeaux, and in a yield of

10,742 apples, obtained only 3.9% wormy. Another plot of five trees received similar treatment with a mist spray and produced 24,316 apples, 1.88% being wormy. A third plot was sprayed like the preceding, except that it was drenched with a coarse spray. It comprised four trees yielding 8109 apples and produced 3.4% wormy fruit. Conversely, a plot of six trees sprayed in 1908 and producing only 21 to 930 apples each, yielded but 2657 apples, 13% being wormy. This latter approximates our results on trees bearing a very small crop. Almost invariably such trees produced a markedly higher percentage of wormy fruit than the more heavily laden ones. Gossard ['08] gave a plot of four trees but one application. They yielded 4836 apples and an average of 95.91% free from codling moth. Two of these trees had a small crop, otherwise the percentage of sound fruit would probably have been higher. One tree [Gossard '09] produced nearly 99% of sound fruit. Ball ['07] as a result of experiments conducted over a series of years, became convinced that the first spray or the first and second sprays, namely, the two given within a week or 10 days after the falling of the petals, would kill 90% of the first brood in Utah, thus destroying many of the progenitors of the second brood and, in addition, enough poison remained on the foliage to kill some 74% of the second generation of apple worms. He estimates that two early sprayings correctly applied, are worth from 6 to 16 times as much as three late ones. These two early sprays killed an average of 98% of the worms of the first brood entering the calyx, and 97% of those of the second, an average of 78% of the first brood entering the sides of the apple and 52% of the second brood attacking the apple in the same way. Melander, apparently basing his recommendations upon practical results over extended areas, has recently come out most emphatically in favor of one spray, claiming that this, if timely and thorough, will result in crops practically immune from codling moth injury.

It may be well to note in passing that Sanderson ['08] as a result of his extensive series of experiments, came to the conclusion that an early spray applied shortly after the blossoms fell, and another approximately three to four weeks later, at the time the codling moth eggs hatch, gave a maximum protection, though he admits that the value of the second application is doubtful when not over 50% of the fruit is likely to be infested or unless a rain follows the first treatment. Obviously, the

great advantage of the early application is that it enables the fruit grower to put the poison where a very large proportion of codling moth larvae will find it before they enter the apple, since about 67% attack the fruit at the blossom end. A second spraying made within a week or 10 days after the blossoms fall, simply makes a more thorough job and is a tacit admission that it is impossible to cover a tree well with one application. The third spraying, namely, when the young apple worms commence their feeding, justifies itself only when conditions have prevented an early application or possible thoroughness in the preceding sprays, is admissible when a poison has been used which may have been washed from the foliage by rains, or may be advised for very badly infested orchards.

With the data at present available we see no reason for urging treatment at the time the second brood of apple worms appear, since if the earlier spraying is thorough there is practically no second brood to be controlled. There are some observations worthy of note in this connection. Lloyd ['07] obtained data showing that Illinois apple stems might be injured even by a spray for the second brood containing but ¼ pound of paris green to 50 gallons of water. The damage was often greatest at the point of attachment of the stem and apple, both being injured. He gives data showing that before this stem injury, nearly all the windfalls were wormy, while subsequently a considerable proportion (18 to over 90%) were uninjured by worms. In spite of this excessive dropping, the crop on the sprayed trees averaged greater than that upon the check trees. Furthermore, he ascertained by careful study that this late application, even when applied after the small apple worms had entered the fruit, resulted in the destruction of many, due to their feeding for a time just under the skin. It is possible that some of those destroyed in this manner were the larvae of the lesser apple worm.

There is little or nothing in the experiments conducted in the East to justify the contention of our Western friends, to the effect that markedly superior results may be obtained by the use of a coarse spray driven by an exceptionally high pressure. We would select a nozzle giving the most uniform and rapid distribution of spray without regard to penetration. We would not be understood as discouraging the employment of high pressure, since this is undoubtedly an important factor in thorough and rapid work, the latter being extremely desirable on account of the limited time when successful applications may

be made. We are thoroughly satisfied that most excellent results can be obtained where conditions permit the use of only moderate pressures. The best time to spray is within a week or 10 days after the blossoms drop and while the green calyx lobes are open [pl 15, fig. 1].

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Hickory leaf stem borer

Acrobasis feltella Dyar[1]

This new species was reared in early July from caterpillars inhabiting hickory stems collected by Mrs A. M. A. Jackson, Warner, Onondaga co., N. Y. This borer, it was stated, was somewhat abundant upon young hickories. It was at first supposed to be identical with Acrobasis angusella Grote, a species also occurring in hickory leaf stems. Dr Dyar states that the adult is separated therefrom by the "conspicuous character of the inner pale band."

Life history. The larva of this new form bores in the interior of the leaf stem, causing a distinct enlargement an inch or more in length and ⅜ inch in diameter. This portion of the stem is eaten so that only thin walls remain, the cavity having a distinct orifice at one extremity and the latter usually connected with a rather extensive, white, frass-filled web an inch to 2 inches long and fastening several leaves together. The larval feeding appears to be confined almost entirely to the interior of the stem. Nothing further is known concerning the habits of this species though it is presumable that there is but one generation annually.

Description. *Larva.* Length ⅝ inch. Head dull amber, the thoracic shield greenish amber, the body nearly smooth, dull greenish or yellowish green, the dorsal vessel being indicated by a dark green stripe. Anal shield dark green, with a few sparse fuscous setae. True legs black. Venter and thorax a little lighter than the dorsum. First thoracic segment with a large lateral tubercle, second thoracic segment with a large, black, sublateral tubercle on either side and with the annulations rather deep.

[1] Dyar, H. G. Ent. Soc. Wash. Proc. 1909. 11:214.

Imago. The adult has been described by Dr Dyar as follows:

Forewing of male with a small patch of black scales beneath subcostally. Wings dark gray, the inner band beyond the subbasal patch of raised scales very broad, creamy white, shading to orange below, especially wide in its lower part. In the male the basal space and all of the thorax are white; in the female, these parts are gray. Discal dots joined. Outer line wavy crenulate, defined by an outward creamy shade. Hind wing light at the base in the male, entirely fuscous in the female. Expanse, 14–17 millimeters.

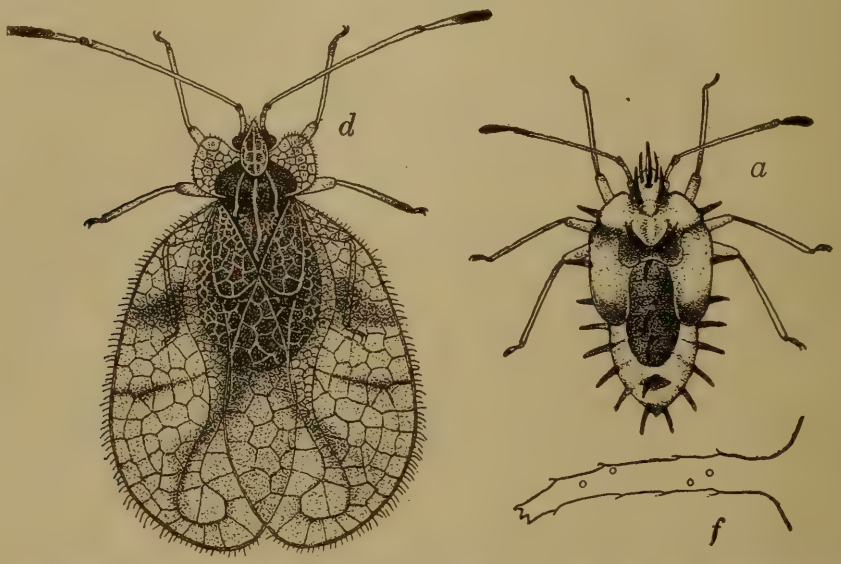

Fig. 1 Rhododendron lace bug: *a* nymph; *d* adult; *f* spine enlarged (after Heidemann)

Rhododendron lace bug

Leptobyrsa explanata Heid.

The delicate, lace-winged bugs excite the admiration of all close observers on account of their exquisite sculpturing. This species is no exception to the rule though on account of its rather serious injuries to Rhododendrons in the vicinity of New York city and also at Rochester, it has been the occasion of considerable complaint. The curiously spined young occur on the underside of the leaves during May and June, while the strikingly marked adults may be seen in early July. This species draws the sap from the underside of the leaf tissues, producing unsightly brown spotting accompanied by more or less serious injury to the foliage. Furthermore, the deposit of the eggs in the leaf tissues is an additional source of injury.

Description. The perfect insect is about ⅛ of an inch long, its delicately sculptured wings [fig. 1*d*] with sharply defined, transverse, brown marks near the middle being characteristic. The young

nymphs are rather long legged and ornamented with conspicuous tapering spines [fig. 1*f*]. This species has been described in detail by Mr Heidemann as follows:

Adult. Body short, oval in the female, more elongate in the male, shining black; membranous parts of pronotum and integument of elytra pale yellowish, semitranslucent, nervures yellowish. Head rather small, black, with three white frontal spines, two approaching each other, the middle one comparatively stouter; besides, there are two other more slender spines extending from behind the eyes towards front. Antennae long, finely pilose, yellowish, the tips infuscated; two basal joints slightly thicker than the following ones, first joint twice the length of second, third a little more than three times as long as fourth. Bucculae yellowish, narrow, angulate and broader behind, the edge upturned a little. Pronotum transverse, feebly convex, coarsely punctured, and shining black; in fresh specimens the sides of pronotum are covered with a whitish film that also extends toward the underside at the sternum. Hood not much inflated, cristate and slightly tapering towards front; covering the head, except the eyes, with quite large areoles at the sides near top and a few smaller ones at lower part. The three pronotal carinae yellowish, the median one strongly foliaceous, as high as crest of hood, rounded on top and slowly declining towards apex of the triangular posterior portion of pronotum, with a row of long, large areoles of which the middle ones are divided by a few cross nervures and embrowned; outer carinae very low, only half as long as the median carina, extending from base of hood to sides of pronotal portion posteriorly; the triangular part of pronotum rather short, yellowish and finely reticulated; membranous pronotal margins strongly rounded behind, reflexed, widening moderately at sides, narrowing toward the neck and reaching the lower part of hood close to the eyes, with two or three rows of average-sized areoles. Elytra ovate, iridescent, extending one half their length beyond abdomen, a little less in the male; strongly rounded from base to apex, broadest behind the middle; discoidal area pyriform and short, angularly raised at the outer nervure, somewhat rounded at apex and broadly scooped out on the upper surface, with three or four rows of quite large areoles at the widest part. Subcostal area subvertical, wider than the discoidal area, having about five rows of irregular small areoles, those of the upper row much larger; costal area broadly expanded, with four or five rows of very large, more or less irregular areoles, diminishing to three and two rows at base. Surface of elytra very peculiarly undulated, with two transverse, sharp impressions, and another at apex formed by the outer nervure of subcostal area; a light transverse fascia on basal half. Median nervure of subcostal area strongly sinuate towards tip of elytra; sutural area at inner part irregularly reticulated with rows of some extremely large areoles. Entire margin of elytra, lateral margins of pronotum, crest of hood, carinae, and most of the nervures beset closely with

long, very fine hairs. Rostral groove uninterrupted, broad at mesosternum and metasternum, angularly closed in front; rostrum reaching metasternum. Abdomen of female broadly rounded at apex, in the male more elongate, the sides of genital segment sinuated; at tip two strong claspers. Length 3.6 millimeters; width of each elytron across widest part, 1.4 millimeters.

Last nymphal stage. Body elongate elliptical, yellowish white, pellucid, some brownish spots on inner side of the wing pads basally and at apex; abdominal segments on the middle and all the appendages or processes toward the tip brownish. Pronotum transverse, lateral margins rounded; hood, median carina, and triangular posterior part of pronotum already indicated. Antennae as long as the whole body, finely pilose, yellowish, tip of the two terminal joints brownish. Wing pads reaching the third abdominal segment. Head with five long processes, of which two at base of head are most prominent and bent forward; two smaller ones on a little elevation of median carina near together; very large processes on each lateral margin of pronotum; two on the mesonotum and a single one at middle of the first, third, fourth, and sixth dorsal segments of abdomen; another on each wing pad; the processes on the lateral margins of abdomen are slightly smaller. These appendages or processes are peculiarly shaped, cylindrical, narrowing toward the apex, the edge of tip armed with two or three small sharp teeth; there are also some pores and short bristles on the surface of these processes visible by high power magnification. Length, 2 millimeters.

Egg. This, according to Heidemann, is cylindric, oval, yellowish white and about .4 millimeters long.

Life history. This species, according to Mr Heidemann, winters in eggs deposited in the epidermis of the leaves, mostly at the sides of the main rib. The eggs hatch probably early in May in this latitude, the recently emerged young being whitish, somewhat transparent and without spines. Later the color becomes greenish white and the antennae extend nearly to the end of the abdomen. In about four days the skin is shed and lateral processes begin to appear which become more apparent in subsequent molts. The partly grown nymphs may be observed on the underside of the leaves from then to early July at which time the insects become full grown.

Food plants and distribution. This species is recorded by Heidemann as quite abundant on Mountain Laurel, Kalmia latifolia and on the Great Laurel, Rhododendron maximum, and occurs along the Atlantic slope from North Carolina northward at least to New York State.

Remedial measures. Experiments with an allied form on asters several years ago demonstrated the feasibility of controlling that species with a whale oil soap solution, 1 pound to 9 gallons of water. Recent work shows that similar treatment with this or other contact insecticides is equally efficient in the case of this Rhododendron pest, provided the application be made to the underside of the foliage in May or early June.

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Plant lice

The season of 1909 was noteworthy because of the great abundance of plant lice. These tiny weaklings were extremely numerous on a variety of fruit trees, seriously affecting the foliage and in not a few instances exercising a very material influence on the development of the fruit. They were also present in unusual force on many other plants, such as currants, cabbage, hops, shade and ornamental trees and shrubs. The foliage was not only badly deformed, thickly smeared with honeydew and then discolored by the sooty fungus growing in this favorable medium, but the excretion was so abundant in many places as to keep sidewalks wet and sticky even on the hottest days.

Small or "aphis" apples

Aside from injury to foliage, there were many complaints on account of the numerous small apples. This latter was probably brought about by the plant lice or aphids being so numerous as to reduce the vitality of the trees at the time the fruit was setting, to such an extent as to prevent the one or two early fertilized blossoms of each cluster securing a sufficient start to outstrip the others and thus result in a large proportion of the fruit dropping at the outset. Instead of the latter, a very desirable and normal outcome, so many blossoms set that the trees were unable in large measure to produce average sized fruit. There was, as a consequence, very many small apples and relatively few good sized to large, marketable fruit. The extent of this was strikingly illustrated on the experimental plots in the orchard of Mr W. H. Hart, Poughkeepsie. The fruit of over 250 experimental trees distributed throughout the orchard and therefore representative, when picked and carefully classified,

showed that in approximately 100,000 apples there were only 54,845 marketable fruit, many of these being rather small, while 41,982 apples were so small as to be practically unmarketable. This small fruit, popularly designated by many growers as "aphis apples," was easily recognized by its small size and frequently irregular shape. It was estimated by one of the fruit growers that in the vicinity of Poughkeepsie approximately 33% of the crop was thus affected though this figure may be somewhat high. Similar injury was very prevalent in orchards in the western part of the State.

Apple aphids

There are four species of plant lice or aphids very likely to occur on our fruit trees. The woolly apple aphis,[1] as is well known, restricts its attack mostly to the vicinity of wounds on trunk and branch and also occurs on the roots. It is rarely abundant enough in New York State to cause material injury. The other three species, known respectively as the European grain aphis, the green apple aphis and the rosy apple aphis, attack the foliage and will be discussed briefly below.

European grain aphis. (Siphocoryne avenae Fabr.). This European species has, until recently, in this country been considered identical with the green apple aphid, a species which has been known to occur in America for many years. This aphid is, judging from available records, probably very generally distributed throughout the United States. It has been recorded as occurring upon apple, pear, quince and plum, and such grains as rye, oats and wheat. This species passes the winter in its shiny, jet black eggs deposited by the females in the fall around the buds of the more terminal shoots, in crevices at the crotches of limbs and under scales of the bark. The eggs hatch about the time the young leaves appear, and the small, green plant lice begin to feed upon the unfolding foliage. These early individuals soon commence to produce living young, the latter shortly attain maturity, develop wings, fly to other trees and continue the process of multiplication. This species may be most easily recognized by the oval, yellowish green or brown body. Investigations have shown that there may be four or five generations in the latitude of Washington, and that by early July the trees are deserted for the grains, grasses or other host

1 Schizoneura lanigera Hausm.

plants. In the fall there is a return migration from the grasses and grains and the deposit of winter eggs as mentioned above.

Green apple aphis (Aphis mali Fabr.). This species, like the preceding, passes the winter as black eggs which are undistinguishable from the above noticed form. The plant louse has a pear-shaped, yellowish green, green or dark green body instead of the oval form of the European grain aphid. The eggs of this widely distributed form hatch a little later in the season, and the plant lice, like the preceding, frequently cause serious curling of the foliage. This plant louse occurs upon the trees throughout the season and, under conditions obtaining in New Jersey, may produce six generations before the appearance of the sexual forms and the deposition of eggs destined to hatch the following season.

Rosy apple aphis (Aphis malifoliae Fitch). This species is easily distinguished from the preceding by its larger size, rounder shape and usually rosy color, though this latter may vary from salmon to tan or even to slaty gray or black, the body being dusted with whitish. This widely distributed aphid, like the preceding, winters as eggs deposited on the trunk and larger limbs. The young plant lice appear with the unfolding of the leaves. There are about three generations produced before the trees are deserted for an unknown food plant. There is a return migration in the fall and the deposition of eggs.

Certain other aphid pests

Cherry aphis (Myzus cerasi Fabr.). This species is more or less abundant every year and, like some of its allies, was excessively numerous the past season. It is easily recognized as the black aphis so prevalent in early summer on sweet cherry foliage, portions of the leaves sometimes being nearly black with insects. Occasionally the attack is so severe as to result in the entire destruction of the leaves for a foot or 2 feet from the tips of the shoots. Such an outbreak means serious injury to the trees.

Hop aphis (Phorodon humuli Schrk.). The hop louse was locally abundant and is occasionally quite injurious to this plant. It is one of the forms known to have two food plants. The winter is passed as small, glossy, black eggs on various species of Prunus or plum, both wild and cultivated. The eggs hatch in early spring and three generations are produced on the

plum prior to the flight in June to the hop vines. There have been, according to careful and extended investigations conducted under the supervision of the late C. V. Riley, at that time entomologist of the federal government, 4 to 12 generations, depending upon weather and other conditions. Winged adults, produced at the end of the season, migrate back to the plum and deposit the black eggs which remain unhatched till the following spring. This peculiarity in the life history of the hop aphis, suggests the desirability of eliminating useless wild and domestic plums in the vicinity of hop yards, and also the wisdom of spraying other plum trees in the spring for the purpose of destroying the plant lice before they have had an opportunity of migrating to the hop.

Corn root aphis (Aphis maidiradicis Forbes). A subterranean species such as this, is very likely to escape notice and this is probably the reason why it is rarely brought to attention in New York State, though it is well known as a corn pest in the Central States. Examples of this species, kindly identified by Mr Pergande, through the courtesy of Dr Howard, were received under date of September 29 from Mrs H. Reineck of Albany, with the statement that she experienced difficulty in raising asters, owing to the abundance of plant lice upon the roots. Specimens submitted for examination showed the roots to be thickly clustered with small, bluish green or reddish brown, wingless plant lice about 1 millimeter long. Young aphids were also observed feeding upon the rootlets. These pests were apparently attended by ants, the latter probably excavating the soil around the roots and possibly constructing chambers in which the plant lice could winter more successfully. Injury by this species in New York State appears to be so rare that, generally speaking, remedial measures may be considered inadvisable. It might be well in case of an infestation in the garden, to pull the plants in late fall and thus destroy in large measure the hibernating quarters of the aphids. Should this not be feasible, many of these plant lice could be destroyed by treating the ground with carbon bisulfid.

Norway maple aphis (Chaitophorus aceris Linn.). This large, yellowish green, brown marked plant louse with long, hairy antennae and reddish eyes is frequently abundant throughout the greater part of the season on the underside of the leaves of Norway maples, and is remarkable for the large

amount of honeydew excreted. The latter occasionally collects in rather thick, viscid masses on the foliage, and not infrequently is so abundant as to keep the sidewalk beneath infested trees wet even in hot summer weather. This insect was excessively numerous in many sections of the State in 1909, seriously injuring the foliage of many beautiful trees and in not a few instances causing 10 to 25% of the leaves to drop. In very severe attacks practically all of the leaves may be seriously affected and a considerable proportion drop before others have an opportunity to develop. This species is usually controlled in midsummer by natural enemies, the beneficial ladybeetles or ladybugs being among the most active.

Painted maple aphis (Drepanaphis acerifolii Thos.). This beautiful little plant louse was very abundant and rather injurious to soft maples in particular, though it occurs in small numbers on the hard or sugar maple. It is easily recognized as a small, red eyed, black and white marked plant louse with prettily marked brown wings. The young are pale yellowish and wingless.

Box elder aphis (Chaitophorus negundinis Thom.). This gregarious species has been somewhat abundant the last few years on the relatively few box elders observed in the vicinity of Albany, N. Y. It is a greenish form, the abdomen being pale green, the head brown, the latter and the prothorax both hairy.

Elm leaf aphis (Callipterus ulmifolii Mon.). This very slight, inconspicuous, pale greenish plant louse was excessively abundant on the underside of American elm leaves, causing serious injuries, especially in the western and southern portions of the State. It was so numerous at Dunkirk and Fulton as to cause considerable annoyance on account of the large amount of honeydew dropping from the trees.

Woolly elm aphis (Schizoneura ulmi Linn.). The woolly elm aphis is easily recognized in June by the badly curled leaves of white elm, usually accompanied by the dropping of wax-powdered pellets of honeydew. This species is sometimes excessively abundant on elm foliage, the affected leaves curling so as to form a cavity which may be brimful of struggling plant lice and particles of whitish honeydew. Professor Gillette is inclined to believe that the woolly aphid, occurring on the bark of elm and known as Schizoneura rileyi Thos., is identical with this form.

Woolly beech leaf aphis (Phyllaphis fagi Linn.). This rather inconspicuous plant louse, occurring on the underside of beech leaves, is most easily recognized by its woolly covering. It has been abundant on purple beeches in Washington park, Albany, N. Y., for the past decade, occasionally becoming very numerous, as was the case in 1909, though never causing perceptible curling of the foliage. A dying, small tree observed had the leaves nearly destroyed by this plant louse.

Woolly larch aphis (Chermes strobilobius Kalt.). This species continues abundant upon larches in Washington park, Albany, N. Y., though it is not especially injurious. The winter is passed in the egg state, over 200 having been counted in an egg mass of moderate size. The young appear in early May and settle on larch needles, at which time they somewhat resemble grains of black gunpowder. They increase in size and in the course of a few weeks, excrete an abundance of white, woolly matter, giving a very characteristic appearance to infested trees.

Pine bark aphis (Chermes pinicorticis Fitch). This species continues abundant on pines in Washington park, Albany, N. Y., and is probably responsible in large measure for the gradual destruction of two groups of young pines, individual trees of which have died from time to time during the past decade. This insect winters as yellowish brown eggs, well protected by the copious, waxy secretion, young appearing in the latitude of Albany, N. Y., from the middle to the latter part of May. The full-grown female is a dark grayish purple and about 1/32 of an inch long. This species has been the occasion of complaint from several sections of the State and has also proved to be a pest on seedling pines in forest nurseries. Attack by this plant louse is very likely to be followed or accompanied by bark borer injury. It has also been observed on balsam. This species is particularly subject to attack by lady-beetles.

Woolly pine aphis (Schizoneura pinicola Thos.). This species, kindly identified by Mr Pergande, through the courtesy of Dr L. O. Howard, was brought to notice by State Forester C. R. Pettis in October on account of its abundance on the roots of seedling pines grown in forest nurseries at Lake Clear Junction, N. Y. The plant lice, he stated, were very abundant upon the roots. Samples submitted for examination

showed that there had been considerable colonies several inches below the surface, the infested points being marked by an abundance of woolly, waxy matter and in some instances there was considerable exudation from the roots, possibly as a result of the injuries inflicted by this plant louse. Mr Pettis, writing under date of October 10, states that the plant lice appear to live in the ground at night but with the appearance of the sun they emerge and fly, the phenomena he observed probably being the normal autumnal flight. The trees affected were all native pines and so far as a superficial examination went, appeared to be in excellent condition.

Gall-making aphids

There are a number of species of plant lice particularly interesting because of the vegetable deformations, more generally termed galls, which they produce. Ordinarily these gall-making species are not very injurious though their effects upon plants are frequently somewhat conspicuous.

Cockscomb elm gall (Colopha ulmicola Fitch). The gall made by this species, on elm foliage, is very common and is easily recognized by the long, irregular, frequently red tipped cockscomb swellings running parallel with the veins and sometimes so abundant as to seriously deform the leaves. Occasionally small trees may bear one or more galls upon almost every leaf, while the foliage of individual branches on larger trees may be badly malformed because of these abnormal growths. The young galls appear about the first of May as slightly elevated ridges on the upper side of the leaf. Soon after, on the opposite surface an elongate opening is seen, and on pulling the walls apart the glossy, olive-brown plant louse is disclosed within the cavity. This is the parent louse. Four or five weeks later or during the month of June the interior of the gall will be found occupied by numerous young grouped around the mother. Within the gall, among its many occupants, are numerous glistening globules of a sweet liquid or honeydew excreted by the plant lice. Later the opening into the gall spreads apart and the insects are thus free to escape. The species is said to winter as eggs deposited in sheltered places on the bark.

Spiny hazel gall (Hamamelistes spinosus Shim.). This peculiar form, as determined by the recent investigations of Mr Pergande, has an extremely interesting life history, occur-

ring as it does, in oval, spiny bud galls on witch-hazel and upon the leaves of birch. The season of 1909 was remarkable on account of the abundance of this species upon birch foliage, both in the vicinity of Albany and Hudson and probably in other portions of the State. The plant lice were so numerous as to cover the foliage with honeydew, which was soon followed by the development of the sooty fungus and the resultant blackening of the leaves. A summary account of this plant louse, accompanied by illustrations, has been given by the writer.[1]

Witch-hazel cone gall (Hormaphis hamamelidis Fitch). The conical, green or reddish galls of this plant louse are more or less abundant upon witch-hazel leaves from year to year and occasionally extremely numerous. This, like the preceding form, migrates to the birches and also has a varied and extremely interesting life cycle, which latter has also been summarized by the writer.[2]

Hickory gall aphid (Phylloxera caryaecaulis Fitch). This is one of the commonest of our Phylloxera galls on hickory and presumably the most destructive, though some other species are occasionally very abundant and undoubtedly seriously affect the trees. The young galls of this species occur in early June, at which time they vary from the size of a pea to that of a small marble and range in color from pale greenish to a bright pink. They are irregularly spheroid, being usually prolonged at the union with the midrib or petiole and with a more or less distinct, somewhat irregular, ventral orifice which is completely closed. Many of the galls are so near each other that they fuse. Each contains a central cavity with its stem mother and numerous young plant lice. Later the galls become green or rosy and as they increase in size the plant lice multiply to such an extent that during the latter part of the period of growth, the inner surface of the gall may be literally covered with numerous young, pale green plant lice. Finally, the distorted tissues die, turn black and leave an ugly, shrunken mass. This is only one of a number of species of Phylloxera likely to occur upon hickory. Mr Pergande, who has made an extended study[3] of the species occurring upon hickory, divides

[1] N. Y. State Mus. Mem. 8, 2:643.

[2] N. Y. State Mus. Mem. 8, 2:639.

[3] N. Amer. Phylloxerinae Affecting Hicoria (Carya) and Other Trees. Davenport Acad. Sci. Proc. 1901. 8:185–273.

the galls into three groups. The thin, paperlike or more or less transparent ones occurring upon leaves, the thicker, fleshy, variform galls always opening beneath and on leaves, those forming elongate folds along the veins, and finally, a fourth class represented by the species discussed above, producing galls on the twigs or leaf petioles. Phylloxera galls on hickory leaves are frequently very numerous and are produced by a number of species, though the leaf inhabiting species are rarely abundant enough to cause material injury. The Phylloxera galls usually have a distinct orifice and may be distinguished from similarly appearing Cecidomyiid galls by the minute plant lice within.

Red elm leaf gall (Pemphigus ulmifusus Walsh). The large, solitary, spindle-shaped galls about 1 inch long, produced by this plant louse, occur on the upper surface of the leaves of red elm. The interior, as in the case of other plant louse galls, is frequently swarming with aphids in various stages of development. This species is somewhat rare in New York State.

Vagabond gall (Pemphigus vagabundus Walsh). This insect produces a rather common leafy deformation. It is simply a peculiar, folded, convolute mass of foliage some 2 inches in diameter and near the tips of the twigs. Occasionally these galls are quite abundant.

Poplar leaf stem gall (Pemphigus populitransversus Riley). This species is sometimes very abundant. The galls are oval, about ½ inch long, somewhat elongate, with transverse openings, and develop near the middle of the leaf petioles of cottonwood during the latter part of the summer. The poplar is also affected by several allied forms.

Spruce gall aphid (Chermes abietis Linn.). The presence of this insect is easily recognized by the cone-shaped, many celled galls formed at the bases of young spruce shoots. These dry, turn brown and open in August, thus allowing the inclosed plant lice to escape. This insect is widely distributed in New York State and has been responsible in recent years for a number of inquiries accompanied by complaints of injury. This latter is due in large measure to the inability of the affected shoot to continue its growth and, as a consequence, the branches soon become irregular and the tree very unsightly.

Honey and honeydew

The superabundance of plant lice was not without its effect upon the apiarist and his products. Honeydew was so abundant that the bees gathered it very largely and in some localities produced a considerable quantity of honey which, under a strict interpretation of the Pure Food Law, could hardly be considered as pure honey, since the latter is held to be the modified nectar or natural sweets of the blossom and not a saccharine excretion from some other insect. Furthermore, the product elaborated from honeydew is not considered a desirable winter food for bees, though it can be safely employed in the spring for brood rearing.

Near the posterior extremity of most plant lice there is a pair of conspicuous processes very generally termed honey tubes, and by many supposed to be the organs from which the honeydew, so prevalent on aphid infested foliage, is produced. It is well known that drops of liquid may appear upon these organs, which might more properly be termed cornicles rather than honey tubes, since the latter designation is misleading, as is shown by the investigations of Professor Horvath, who states, according to an abstract prepared by Mr Bueno, that when "an ant strokes an aphis with its antennae a clear drop appears always at the end of the abdomen whilst the cornicles excrete nothing. On the other hand, if an aphis be picked up in the fingers, or if it be touched with a straw, a tiny drop at once appears at one or both cornicles which is always colored." Honeydew must thus be regarded as a waste product of the body rather than as a highly elaborated secretion. Dr Horvath concludes that the "cornicles of the aphids are the excretory canals of wax-producing glands differentiated in a special manner and the product of which is a means of defense against the Coccinellidae and the Chrysopidae."

Climate and plant lice

It is evident to even the most casual observer, that delicate, nearly helpless insects like plant lice, feeding almost unprotected upon the foliage of various trees, must be more or less susceptible to climatic conditions. This is well substantiated by the behavior of various species. The remarkable abundance of these small insects the past year was comparable only with the outbreaks of 1897 and 1903, years distinguished by the superabundance of these pests. Observation and weather records show a distinct correlation between a low, unseasonable tem-

perature and the multiplication of plant lice. The past summer was remarkably cool and backward, a marked change for the better occurring June 21. That the earlier cool weather was favorable to the plant lice, was evidenced by the hosts occurring upon the leaves of many trees. The reason is probably found in the fact that the unusually low temperature prevented the normal activity of such natural enemies as ladybeetles, flower flies and minute 4-winged parasites. Prior to the appearance of warm weather numerous lots of plant lice, showing no evidence of having been materially injured by natural enemies of one kind or another, were received. Shortly after the rise in temperature a very different condition of affairs obtained. Leaves injured by plant lice continued to be received, but in almost every case a few natural enemies had begun to reduce the numbers of the pests, or especially toward the end of the outbreak, most had been destroyed and the leaves only bore evidence of earlier injury. Recent observations on the spring grain aphis in the Southern and Middle States have shown a similar correlation between temperature and the development of plant lice and their enemies.

The obvious lesson to be drawn from the above is that plant lice outbreaks may be expected when the late spring weather is unusually cool and backward, unless it is accompanied by pelting rains which are undoubtedly of considerable service in destroying exposed aphids. The advisability of adopting direct repressive measures in specific instances, must depend in large measure upon the probability of warmer weather developing soon enough so that natural enemies may check the aphids before material injury is caused.

Ants and aphids

There is a somewhat intimate relation existing between ants and aphids. The former appreciate the sweet excretions of the latter and not infrequently protect and even construct shelters for various species of plant lice. The popular characterization of aphids as the milch cows of ants, expresses fairly correctly the relationship which may exist between such divergent forms, though possibly it implies too much interdependence on the part of both. Ants can subsist without the secretions of plant lice; and conversely, protection by ants is not necessary to the existence of aphids. There are well recognized cases where ants

are potent factors in increasing the destructiveness of aphids. One of the best known is the case of the corn root aphid[1] and the corn field ant.[2] This ant colonizes the aphid in cultivated fields, on the roots of weeds and corn, and materially increases its destructiveness. The casual nature of this relationship is exhibited by the observations in Louisiana, of Prof. Wilmon Newell on the recently introduced Argentine ant, Iridomyrmex humilis Mayr. and native plant lice which are colonized by this species and, as a consequence, the latter are decidedly more injurious in sections where the Argentine ant is abundant.

Natural enemies

The almost helpless plant lice are subject to attack by a number of insect enemies. The beneficial ladybeetles or ladybugs, easily recognized, as a rule, by their red color and conspicuous black dots, are among the most serviceable of these natural enemies. They, in association with their ugly, black grubs, are frequently found on badly infested trees, feeding voraciously and destroying hordes of these pests. The 2-spotted ladybeetle[3] is one of the more common of these forms, though the ocellate or 15-spotted ladybeetle[4] is frequently found in numbers, especially on shade trees. Another common form is the 9-spotted ladybeetle.[5]

The important part played by the delicate, handsome flower or syrphid flies, should not be overlooked. These insects are usually brightly marked with yellowish and brown, generally with conspicuous, reddish eyes and may frequently be seen hovering in bright sunlight. They deposit their delicately sculptured eggs in colonies of the plant lice, and the greenish or yellowish, sometimes red marked, varicolored maggots, less than half an inch long, devour hosts of aphids before they attain maturity. These active enemies of plant lice are easily distinguished from all other species found in such situations, by the body gradually enlarging from the head backwards. The maggots seize individual plant lice, raise them from the leaf and quickly drain the body of its vital fluids.

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[1] Aphis maidiradicis Forbes.
[2] Lasius niger americanus.
[3] Adalia bipunctata Linn.
[4] Anatis ocellata Linn.
[5] Coccinella novem-notata Hbst.

There are a number of tiny, 4-winged, parasitic wasps which subsist entirely on plant lice. These beneficial insects deposit their eggs in their victims, one in each, and the maggots develop rapidly at the expense of the host. The infested aphids are easily recognized by the greatly swollen, frequently globular and usually brown abdomen. Occasionally a very large proportion of the many plant lice on individual branches, or even entire shrubs or trees, are affected in this manner. Each plant louse perishes, while the maggot within, before completing its transformations, fastens the body of its host to the plant. The parasite itself, as it escapes, cuts a characteristic, circular orifice, leaving the central portion or lid attached by a narrow hinge. It is therefore very easy to estimate the proportion of plant lice destroyed by these parasites.

In addition to the above, the voracious larvae of the extremely delicate, lace-winged flies, destroy hosts of aphids. The golden eyed parent insects are usually light green and easily distinguished by the large wings adorned with numerous minutely spined veins. They deposit their oval, whitish eggs in picturesque groups on leaves or twigs, each egg supported by a slender, threadlike stem nearly an inch long. The larvae are rather flattened, 6-legged creatures, usually variably marked with brown and yellow, and remarkable because of the greatly produced jaws. Plant lice and other small insects are seized in these enormous jaws and quickly perish as the body juices are drawn through the hollow cavities of the mandibles.

Remedial measures

The experience of the last few years has demonstrated the futility of depending upon the ordinary winter or early spring applications of lime-sulfur washes for the destruction of aphid eggs upon our fruit trees. There may be some reduction but the percentage killed in this manner is so small as to be practically negligible.

Most fruit growers are thoroughly familiar with the curling leaves quickly following plant lice outbreaks, and appreciate the difficulty of destroying the insects after the attack has progressed thus far, owing to the impossibility of hitting the plant lice with any contact insecticide. Experience has demonstrated time and again, the practicability of destroying these minute enemies of our plants, by thorough applications of con-

tact insecticides, such as tobacco preparations, whale oil soap solutions, kerosene emulsions or even dilute preparations of some of the commercial petroleum compounds now on the market under various trade names.

Tobacco preparations of various kinds have long been used for the destruction of plant lice, though some experience is necessary to secure the proper dilution, owing to the variability of waste tobacco products from which decoctions are usually prepared. There are now on the market a number of ready-made tobacco extracts. A most promising one is known as black leaf extract. It has given very good results in an experimental way, even when diluted with 60 parts of water.

The experience of the last season or two has also demonstrated the feasibility of employing a dilute lime-sulfur wash. Several practical orchardists have used the better grades of commercial lime-sulfur washes, diluted with 40 parts of water and adding thereto two pounds of lead arsenate to each 50 gallons, making the application at the proper time for controlling codling moth. It has been found effective, so far as the last named pest is concerned, extremely serviceable in destroying plant lice and of great value as a fungicide. It is possible that this combination or some modification may ultimately take the place of the poisoned bordeaux mixture and solve for all time the problem of controlling plant lice outbreaks, since one thorough spraying with a contact insecticide just after the blossoms fall, would probably obviate the necessity of any further treatment for plant lice, particularly if this was an annual practice.

The insecticide to be employed must depend somewhat upon conditions. There is no doubt but that a thorough application of a whale oil soap solution, used at the rate of one pound to six or seven gallons of water, is very effective. Even a strong suds of ivory soap, approximately a five cent cake to eight gallons of water, is extremely serviceable and may be employed upon a large variety of plants without injury. The standard kerosene emulsion, diluted with 9 to 15 or more parts of water, is equally valuable. Ready-made oil emulsions, requiring dilution only before application, are on the market and are much more convenient for the small fruit grower.

The essential in all these cases, so far as plant lice are concerned, is to make the application before the foliage has be-

come badly curled. The need of special treatment for aphis outbreaks must, of necessity, depend upon several factors, namely, favorable weather conditions and the relative abundance of natural enemies. It has been shown above that abnormally cool weather in the spring and early summer is likely to be followed by aphid outbreaks, owing to the fact that plant lice reproduce readily under such conditions, while the activities of their natural enemies are seriously hindered. Consequently, an incipient attack by plant lice, accompanied by a scarcity of natural enemies and the probability of continued cool weather, should serve as a warning to the fruit grower and result in immediate spraying.

NOTES FOR THE YEAR

The following are brief notices of some of the more injurious species which have come to attention from time to time throughout the season.

Fruit tree pests

Fruit tree bark beetle (Eccoptogaster rugulosus Ratz.). This insect is more or less prevalent from year to year and is best known on account of its injuries to plum and peach. The past season the writer found a large apple tree in the orchard of William Page of Bethany, N. Y. which had evidently been killed by this insect. It may possibly have been in an unhealthy condition prior to the attack though the numerous galleries of the borers on practically all of the smaller limbs give unquestioned evidence that this species was the initial cause of the trouble. The operations of this pest were also observed in a young pear orchard at North Rose, one small tree having been killed in early August this season and others exhibiting more or less evidence of serious injury.

Canker worms. These voracious leaf feeders have been allowed to continue their devastations in the southeastern portion of New York State in particular. Hundreds of apple trees in Port Chester and northward were practically stripped of leaves the past season and from the appearance of the trees one might infer that this condition had prevailed for a number of years past. These common pests, easily controlled by timely applications of an arsenical poison or by the employment of sticky bands, have been noticed innumerable times. A summary discussion of these insects and methods of controlling them is

given in the writer's report for 1908 [N. Y. State Mus. Bul. 134, p. 45–47].

Tarnished plant bug (Lygus pratensis Linn.). Almost every year we receive inquiries as to the cause of deformed apples. These can not be answered satisfactorily in all cases, though recent investigations indicate that in the above named species we have one of the offenders in this respect. The tarnished plant bug is a small, yellowish and black, angular insect about ¼ of an inch long. It occurs on a considerable variety of plants. The investigations of Dr Taylor in Missouri have shown that this familiar species may deposit eggs under the skin of young apples. The injured portion heals with the formation of corky tissue and fails to grow. Thus, as the apple develops, an unsightly, craterlike depression is produced, materially affecting the value of the fruit. There is no practical method of controlling this pest, aside from keeping the orchard and its surroundings as free from brush, coarse weeds and other shelter as possible.

Rose leaf hopper (Typhlocyba rosae Harr.). This species was found October 2, 1909 in considerable numbers on the young apple trees of Mr George T. Powell, Ghent, N. Y. The foliage was badly specked by this insect, in some instances the damage almost approximating the injury inflicted by the grape leaf hopper, Typhlocyba comes Say in the Chautauqua region. There was every indication that the insects had bred in considerable numbers upon the apple, particularly toward the latter part of the season, since cast skins were rather numerous on the foliage. Rose bushes were certainly not abundant in the vicinity. This attack though unusual, is not unprecedented, since the late C. V. Riley recorded this species as abundant on apple foliage at Burlington, Vt., in 1892, while Prof. G. C. Davis, according to Professor Gillette took specimens at the Michigan Agricultural College on the foliage of apple, plum, tame cherry, currant and grape. This species, should it become abundant, can be easily controlled by the application of a contact insecticide before the leaf hoppers attain maturity and are therefore able to fly.

San Jose scale (Aspidiotus perniciosus Comst.). This pest, while not attracting such widespread notice as in earlier years, has continued to multiply and is slowly becoming established in sections previously uninfested. A large number of fruit trees in the Hudson valley have been seriously injured or destroyed by

this scale insect in recent years. These injuries or losses have almost invariably followed neglect, intentional or otherwise. The experience of another season has but served to confirm the findings of earlier years and emphasize the importance of a lime-sulfur wash in checking this pest. Some practical fruit growers have been able to obtain such excellent results that their neighbors have raised the question as to whether the pest was really present. Such gratifying results have not only been obtained with the ordinary home-made lime-sulfur wash, but also with some of the commercial preparations for sale in this State. The latter appeal very strongly to some fruit growers, since they only require dilution prior to application. The Cordley lime-sulfur wash, a formula which calls for approximately twice as much sulfur as lime, has been used in several places with great satisfaction, particularly as it can be made up in large quantities and held indefinitely without danger of the sulfides crystalizing. A dilution of the commercial lime-sulfur wash is also being used as a summer spray with excellent results though we would remind growers that sufficient time has not elapsed, since this method of application has been used, to permit of exhaustive tests.

An investigation of the orchard belonging to Mr W. H. Hart at Poughkeepsie, N. Y. shows that he had been able to control the San José scale in a most gratifying manner. Trees which five or six years ago were so seriously affected that perhaps a quarter of the tops had died and the indications were that the trees might be killed within a few years, are now in a most vigorous condition and well laden with fruit. This has been brought about largely by spraying with a lime-sulfur wash, the application being made entirely from the ground, since the uneven surface precludes the successful employment of towers. The badly affected trees noted above had the tops cut out some three or four years ago, in some instances limbs 3 inches in diameter being removed [pl. 20, 21]. There was some suckering following this operation, yet there has been a vigorous growth and a bounteous production of fruit. Careful observation is necessary to recognize the trees which have been treated in this way. Mr Hart experiences no difficulty in controlling the San José scale with a lime-sulfur wash, provided conditions allow two applications each spring with the wind in opposite directions. He finds a stiff breeze necessary to carry the spray throughout the entire tree. Much of the fruit in Mr Hart's orchard is practically free from San José scale, aside from occasional branches

which were inadvertently missed during the spraying operations. Last spring Mr Hart employed the Cordley lime-sulfur wash and proposes to boil, the coming November, sufficient material for the spring application of 1910.

West Indian peach scale (Aulacaspis pentagona Targ.). A small branch of Prunus pseudo-cerasus was received from New Rochelle through nursery inspector T. F. Niles accompanied by the statement that this scale insect had been observed by him for some years in the vicinity of New York city. The specimens examined came from a tree which had been set at least three and probably five years ago, presumably being imported from Japan. The portion of the limb submitted for examination was very badly infested, showing that the insect had apparently thrived in this climate though it was supposedly not hardy north of Washington, D. C.

Oyster scale (Lepidosaphes ulmi Linn.). This species, easily recognized by its brown, oyster shell shaped scale, some 1/8 of an inch long, continues to be abundant here and there, occasioning complaint on the part of the fruit grower and frequently causing serious injury to young trees. As has been previously noted, it displays a marked prolificacy on poplar. This pest may best be controlled by thorough spraying with a contact insecticide at the time the minute, yellowish young are crawling in numbers, namely, the latter part of May or early in June. Winter applications of a lime-sulfur wash have given good results in the hands of some and are worthy of further trial. The later the application can be made without injury to the tree, the better the prospects of satisfactory results following. This wash seems to prevent the establishment of the young rather than destroy the eggs.

Blister mite (Eriophyes pyri Nal.). This minute enemy of the fruit grower is becoming increasingly abundant in the Hudson valley, bad infestations having been reported to the writer from several Columbia county localities and also from Washingtonville. The general characteristics of the work of this pest and methods of controlling it have been given by the writer in his preceding report [N. Y. State Mus. Bul. 134, p. 48].

Small fruit insects

Grape blossom midge (Contarinia johnsoni Sling.). We were extremely fortunate in rearing this tiny midge last spring from material collected the preceding June. The parent insect is

a small, delicate, pale yellowish fly only about 1/25 of an inch long. The male can be recognized by the long, knobbed, hairy feelers or antennae one half longer than the body. The female is about 1/16 of an inch long and may be distinguished by the shorter, less densely haired feelers or antennae. The slender ovipositor, as long as the body in this sex, is well adapted to placing the tiny eggs within the developing floral tissues. Field observations June 15–17 showed that this midge was fully as abundant in the Chautauqua region as in 1908. The work of these insects in the vineyard of Mr H. L. Cumming of Fredonia resulted in the destruction of a considerable proportion of his Early Moore grapes, possibly over 75%. This midge not only causes serious loss by blasting numerous grapes in the bud, but inflicts damage by destroying a few grapes in many clusters, thus materially affecting the appearance of the bunches and lowering their commercial value. The youngest larvae found June 15 were probably but two or three days old, while many were fully half grown and would presumably desert the blossom buds within four days to a week. No midges were seen flying in the vineyard either in the afternoon or early evening. A close examination of cobwebs and windows in the near vicinity of the badly infested Early Moore vines resulted in finding no midges. Similar conditions obtained near somewhat badly infested Concord vines in the vineyard of D. K. Falvay at Westfield. The midges are apparently not attracted to any extent by light and probably remain near their food plants, as is the case with the violet midge, Contarinia violicola Coq. It is probable that the grape blossom midges fly in normal seasons about the first of June. An extended account accompanied by detailed descriptions of the larvae and both sexes is given in the writer's report for 1908 [N. Y. State Mus. Bul. 134, p. 15–19].

Tree crickets (Oecanthus sp.). These insects, though predaceous and therefore beneficial, have the unfortunate habit of depositing their eggs, which remain unhatched till the following spring, in woody tissues. A very large proportion of the raspberry canes in a patch near Albany were seriously injured last winter by this insect. Recent investigations conducted at the Agricultural Stations located at Geneva and Ithaca have shown that the snowy tree cricket, Oecanthus niveus DeG. is not, as has formerly been supposed, the chief offender in this respect. The snowy tree cricket usually deposits its eggs singly or in pairs in apple twigs. The studies of Professor Parrott show that this in-

jury is very likely to be followed by blight infection. The species thus far known to be responsible for the long series of egg punctures in raspberry, blackberry and other soft stemmed plants are the black horned tree cricket, Oecanthus nigricornis Walk. and the 4-spotted tree cricket, Oecanthus quadripunctatus Beutm. This injury is very likely to be followed by the cane splitting or even breaking during the winter and, in some instances, as many as three fourths of the canes in a large patch may be seriously injured. The tree crickets are most abundant among coarse weeds and shrubby growths, consequently, the adoption of clean cultural methods, so far as possible, will be of considerable service in reducing their numbers and preventing subsequent damage.

Miscellaneous

Say's blister beetle (Pomphopoea sayi Lec.). This large, usually rare blister beetle is nearly an inch long and is easily distinguished from allied forms by its rather stout, olive-green body and the shining black, orange banded legs. This species was quite abundant the latter part of June and early in July at Quaker Street, Schenectady co. and in the vicinity of Voorheesville, Albany co. In the first named locality it was said to be swarming upon roses and other plants, devouring much foliage and causing considerable injury, while at Voorheesville it destroyed many of the blossoms on locust trees and fears were entertained of serious injury to crops. It is interesting to note that our records show that this species was abundant in the same vicinity in 1900. This blister beetle usually disappears before material damage has been inflicted.

Army worm (Heliophila unipuncta Haw.). This widely known insect was very abundant on Long Island causing serious injury to wheat fields at Oakdale, while similar devastations were reported from Greenlawn, the Hamptons and Orient. This pest was abundant in limited localities at least, in southeastern Westchester county, as was evidenced by the writer finding July 2, numerous caterpillars on the estate of W. W. Cook at Port Chester. A nearby outbreak was also reported. This species attracts notice only when the hordes of caterpillars devour all of the foliage in the immediate vicinity and then begin to march as though by a common impulse in search of provender. A relatively insignificant factor may result in army worm depredations being observed. A few years ago the writer's attention was called to a strip of grass

land where hordes of the pest appeared, though none were observed on either side. The only difference that was known to exist between infested and uninfested territory was that the infested territory had a little earlier in the season suffered rather severely from a hailstorm. It is probable that the hail destroyed enough of the grass so that the caterpillars were compelled to seek food elsewhere, though under normal conditions they would not have attracted notice.

An army worm outbreak requires prompt treatment. Grass or grain in badly infested fields, if of any value, should be cut and removed at once and the migration or marching of the hungry caterpillars prevented by digging slight ditches or turning furrows toward the advancing horde. The ditches and furrows can be made more effective by digging small holes at intervals of 15 or 20 feet in which the caterpillars turning to either side, fall. They can then be readily destroyed by burying. Bands of tar are serviceable in checking the advance of the pests and may be made more effective by putting the tar upon boards and setting the latter on edge. Conditions occasionally warrant the poisoning of a strip in front of the marching caterpillars, in order to destroy them and prevent further injury. Paris green, london purple or even white arsenic is preferable for this purpose to the slower acting arsenate of lead. Masses of caterpillars can be killed by liberal spraying with a kerosene emulsion or a strong soap solution. Not infrequently these outbreaks are accompanied by the presence of numerous natural enemies such as Tachina flies which are similar to and larger than the ordinary house fly. These beneficial parasites deposit oval, rather conspicuous white eggs on the caterpillars, usually just a little behind the head. An abundance of these flies or other natural enemies such as the ferocious ground beetles may render it unnecessary to take active measures for the destruction of the caterpillars, because under such conditions there is comparatively little danger of any number attaining maturity. On the other hand, indiscriminate destruction of the parasitized caterpillars may result in the annihilation of numerous beneficial insects.

Luminous larvae (*Phengodes plumosa* Oliv.). The common lightning bug or more properly lightning beetle, *Photuris pennsylvanica* DeG. is well known, though its luminous larvae, occasionally observed in decaying wood,

are rarely seen. The past season our attention was called to two pale yellowish, rather slender, curled larvae about an inch and a quarter long and resembling in a general way, the more familiar larvae of the snapping beetles, though easily distinguished therefrom by their luminosity. These larvae, kindly identified by Mr H. G. Barber through the courtesy of Dr Howard, proved to be half grown individuals of the northern form of Phengodes plumosa Oliv. They were taken by Mr Joseph E. Brown in Fairfield co., Connecticut. This species undoubtedly occurs in New York State. Similar luminous larvae were found in some numbers about Newton Centre, Mass. in June 1873 and have subsequently been observed from time to time and for the most part were supposed to belong to the genus Melanactes or Asaphes.

The full grown larva is about an inch and half long and may be at once recognized in the dark at least, by the bright light shining from the spiracles and visible through the membranes connecting the different segments of the body. A larger species, Phengodes laticollis Lec. has a larva 2¾ inches long which, according to Prof. G. F. Atkinson, produces a brilliant, bluish white light visible both through the spiracles and the membranes connecting the body segments. The male of this form is comparatively insignificant, being only about ¾ of an inch in length. An interesting fact in connection with these insects is that this grublike, luminous form remains in this condition when mature, being simply a wingless, larviform female. These peculiar insects occur in the ground and have been observed about the roots of grasses and under hedges. They come from their retreats at night, at which time they are most likely to be seen.

A museum pest (Anthrenus verbasci Linn.). It is well known that this small beetle, easily distinguished from the larger, more brightly colored, red, white and black carpet beetle, Anthrenus scrophulariae Linn. by its dull yellowish and gray, irregular markings, feeds upon a considerable variety of dry animal and vegetable substances. Two ears of corn infested by this insect were received April 4, 1902 and placed in a two-quart Mason jar and kept tightly closed. There was no moisture aside from that in the somewhat dried corn. Breeding has continued uninterruptedly to June 1910, a period of over eight years. At the end of this time the bottom of

the jar was nearly covered with fine, white, globose particles, apparently starch grains falling from the eaten kernels of corn, and a thick mass of the brown larval skins and other debris. This record is interesting since it shows how long an insect is capable of subsisting under such adverse conditions.

Shade tree pests

Elm leaf beetle (Galerucella luteola Mull.). This notorious shade tree pest continues to attract notice on account of the serious injuries inflicted upon elm trees, especially the European species. A noteworthy feature has been, judging from the reports and specimens, the unusual abundance of this insect on Long Island. Reports accompanied by specimens showing serious injury were received from Northport, St James, Oakdale and Greenport. The pest was injurious in the Hudson valley and would have caused extensive defoliation in Albany and Troy if it had not been for the systematic spraying of most of the trees. This insect continues to be a pest in Saratoga Springs and at Sandy Hill a number of trees have been partially defoliated as a result of its work. Complaints of injury were also received from Schenectady. Specimens of this beetle were received from Amsterdam, a new though by no means unexpected locality. This pest will probably continue to spread through the Hudson valley and become a rather serious pest in many cities and villages in western New York. It is already ranked as one of the most dangerous shade tree pests in Ithaca on account of the ravages of the past few years.

Experience has repeatedly demonstrated the possibility of keeping the foliage, even of European elms practically intact throughout the season by thorough and timely spraying with an arsenical poison. There is frequently difficulty in getting the work executed in a proper manner. Altogether too often, possibly through a mistaken notion of economy, the beginning of operations is so greatly delayed in the spring that it is impossible to spray the trees satisfactorily within the time during which such work can be done to advantage. The most effectual spraying for elm leaf beetle must be done between the middle of May and the 25th of June. It is practically useless to apply poison after the grubs commence to forsake the trees, unless the foliage has been so thoroughly skeletonized that the majority of the leaves will drop and a new crop ap-

pear. Spraying for the protection of these latter is always justified by results and late applications may also be serviceable in protecting foliage which had escaped injury earlier in the season. Altogether too few realize the very limited time during which work against this species can be prosecuted to advantage and only occasionally do we run across a party who appreciates what can be accomplished by thorough and timely work.

Bronze birch borer (Agrilus anxius Gory). This pernicious enemy of birch trees has continued its ravages here and there throughout the State. It is particularly common in Rochester, Buffalo and vicinity, where numerous trees have been destroyed and others are being killed. It is worse than useless to leave an affected tree standing, since the borers in the bark appear another spring and continue their destructive operations. There is nothing better than to cut and burn, during the winter or early spring, all birch trees or portions of trees showing the characteristic dying of the top, produced by the operations of this flat-headed borer.

Sugar maple borer (Plagionotus speciosus Say). Retiring though this insect may be in its habits, it is nevertheless one of the important enemies of our sugar maples. Investigations last summer resulted in finding several magnificent trees at Fulton, N. Y. which had been seriously injured, if not practically destroyed by this pest. At the time of our visit July 13, the black, brilliantly golden marked, stout beetles were extraordinarily numerous upon several trees, as is evidenced by our capturing 10 or 12 within 30 minutes. Never before have we found the insects so abundant in a locality. The beetles deposit their eggs in midsummer in slitlike gashes here and there in the bark, particularly at the base of the larger limbs, the sap flowing from the wounds usually producing an oval, discolored area, which is frequently made more conspicuous by a few particles of borings hanging from a slender thread. The young grubs may be found near the point of entrance during the fall and early spring. The second year the grub has increased materially in size and when full-grown may make a transverse or oblique gallery just under the bark and continue sometimes half way around a tree 18 inches in diameter. This practically girdles the maple and is almost invariably followed by the bark slowly dying on the affected

side, until eventually half of the tree may succumb to the injury. This pest, besides breeding in the trunk as described, also injures the branches, not infrequently causing the death of one or two limbs or possibly of all those on one side of the tree.

Affected trees should first have all the dead wood removed so far as possible, taking care to protect the cut surfaces with applications of tar or any good roofing paint. Next, carefully examine the trees for signs of borers, digging out the pests if possible, since the pernicious grubs if left to themselves, are likely to cause much more injury than would result from the judicious use of the knife. Wounds of this character should be carefully protected with tar or paint. Each fall the trees should be closely examined for irregular, discolored patches about the size of a nickel, caused by the sap oozing from the slitlike oviposition scars. It is comparatively easy to dig out the young grubs. Their early destruction is much more preferable to extended excavations in search of the nearly full-grown borer.

European elm case bearer (Coleophora limosipennella Dup.). The peculiar, somewhat flattened cases of this species were first brought to the writer's attention in 1901. It is a European form which evidently became established in this country at about that period and is now generally distributed in the vicinity of New York city. Complaints of injury, accompanied by infested leaves, were received from Oakdale, N. Y. The writer observed it at Oyster Bay in 1906, at which time its operations approached in seriousness those of the much better known elm leaf beetle. The general injury by these two forms is somewhat similar, though easily distinguished. The areas mined by the case bearers are distinctly rectangular and bounded on either side, as a rule, by a parallel vein and extending rather evenly for some distance from the central feeding hole, the latter easily seen when looking upward toward a bright sky. The eroded, semitransparent, skeletonized areas produced by elm leaf beetle larvae are at once distinguished by their greater irregularity, the lack of the central feeding orifice and the fact that there is no mining of the foliage. This more recently introduced pest should be watched closely and can be controlled by early and thorough spraying with an arsenical poison, making the application at the time the leaves begin to appear.

False cottony maple scale (Phenacoccus acericola King). This insect has been abundant and injurious in the vicinity of New York city in recent years. The city of Mount Vernon appears to have been one of the chief sufferers, judging from specimens and communications received from that locality. This pest is easily distinguished from the older and better known cottony maple scale[1] by the fact that it occurs in conspicuous felted masses upon the trunks of infested trees and also has large, cottony aggregations on the foliage, two situations where the cottony maple scale is never found with its conspicuous white covering. The last named insect, though its inconspicuous naked young occur upon the foliage, is rarely observed except on the underside of the limbs after the females have developed their characteristic, cottony masses protruding from under a conspicuous brown scale. This species can be controlled by thorough applications, in winter or early spring, with a contact insecticide, using one pound of whale oil soap to a gallon of water. The kerosene emulsion, the standard formula diluted with four parts of water, has been found very effective in controlling the cottony maple scale and would doubtless prove equally efficient in the case of its associate. Several oil preparations now on the market under various trade names have also been used successfully.

Forest insects

Snow-white linden moth (Ennomos subsignarius Hubn.). This destructive span worm first came to notice in recent years during the summer of 1907 because of extensive defoliations in the Catskills. The ravages of that season were more extended the following summer and then included areas in the Adirondacks as well as in the Catskills. The extended outbreak of 1908 was also accompanied by noteworthy flights of the snow-white millers in many cities and villages of the Hudson valley. The past season has again witnessed extensive injury in the Catskills, this pest causing a large amount of damage to forests in the vicinity of Cooks Falls, Delaware co. and being particularly injurious in the township of Denning, Ulster co. Mr Alexander Tison, writing of conditions under date of June 24, states that in 1908 the measuring worm de-

[1] Pulvinaria vitis Linn.

nuded great tracts of timber on the mountain side and reports that while the worms are still very young there is every indication that they will be more numerous than they were last year. The prediction appears to have been abundantly verified by subsequent experience. Mr Walter Hannah of Poughkeepsie states that on July 4 he ascended Slide mountain and on the next day crossed Mount Cornell and the Wittenberg. All the way up from Winnesook lake the trees and undergrowth were literally covered with caterpillars which were eating leaves and strewing the ground with irregular shaped pieces. The pests were particularly bad on the maples and birches. Mrs Olive Wade of Brooklyn also records extensive injuries in the township of Denning. Mr Walter W. Lewis of Dahlia, Sullivan co. reported under date of July 26 that these caterpillars had defoliated hundreds of trees on his farm and in the adjoining neighborhood.

The remarkable flights of moths recorded in 1908 were repeated in 1909. Swarms of the moths or millers about the street lights in New York city this season were recorded by the *Daily Press* of July 26 and a similar flight though not so extensive was observed in Albany the night of July 29. The remarkable urban visitations of 1908 were not followed, as was anticipated, by unusual injury to shade trees and the same would undoubtedly be true of the outbreak the past season. The English sparrow, as recorded previously, displayed most commendable activity in following up and destroying the moths and was probably an important factor in preventing injuries to shade trees.

We would reiterate that the recent extended outbreaks by this leaf feeder and other enemies destructive to forest trees must, in our judgment, be attributed in large measure to the relative paucity of bird life. Some years ago Dr William T. Hornaday of the New York Zoological Society calculated that there had been a decrease of about 48% in the number of our native birds. This estimate, taken in connection with the enormous number of insects devoured by birds, is exceedingly significant. For example, a pair of tanagers has been observed to eat 35 newly hatched caterpillars in a minute and to continue this for 18 minutes, making a total in this short time of 630 caterpillars destroyed. Two Maryland yellowthroats, it is estimated, devoured 7000 plant lice within an hour. A nearly fledged young crow, it is stated, requires at least 10

ounces of food daily, while an adult needs 8 ounces. Birds, on account of their great mobility, are admirably fitted to concentrate their attacks upon outbreaks of leaf-feeding caterpillars. Repeated observations by competent naturalists have shown that this frequently occurs in nature. The reckless and criminal slaughter of these beneficial forms in recent years is beginning to have its effect upon animal and vegetable life and we are just commencing to harvest the results. The indiscriminate destruction of bird life should be checked at once by prohibiting promiscuous shooting, by suppressing egg destruction or egg collection by boys, by doing away with cats so far as possible and by keeping hawks, crows and jays within bound. Some attention should also be given to rendering local conditions more attractive to birds. The adoption of such measures, we believe, would have a most important influence in checking the above mentioned and similar outbreaks. This would not mean large expenditures and, if generally supported, would do much toward repopulating the country with its normal quota of birds and thus in large measure restoring the balance of nature. Owing to the extensive areas infested and the comparatively low price of wood and its products, we can hardly hope for the adoption of other methods for some years to come. More extended discussions of this insect have been given by the writer in the 23d [1] and 24th [2] reports.

Spruce bud moth (Tortrix fumiferana Clem.). The past season was noteworthy because of an unusual flight in late July, of the small, brown moths belonging to this species. These insects were sufficiently abundant to attract local notice in Albany, Utica, Rome, Auburn, Syracuse, Geneva, Batavia, Binghamton, Ithaca, Olean, Boonville and doubtless many other localities. This insect is well known as a serious enemy of spruce. It was considered by Dr Packard as one of the most destructive enemies of this valuable tree in certain portions of Maine. The unusual abundance of this insect over such a large territory is undoubtedly due to favorable climatic or other conditions and may possibly be followed by a serious injury another season. It may be that this general record is to be explained by the earlier flight of the snow-white linden moth drawing attention to other insects and resulting in many observations of phenomena which otherwise might have passed unrecorded.

[1] N. Y. State Mus. Bul. 124. 1908. p. 23–28.
[2] N. Y. State Mus. Bul. 134. 1909. p. 51–54.

Hickory bark borer (Eccoptogaster quadrispinosus Say). An examination of the hickories in Prospect park, Brooklyn, in company with arboriculturist J. J. Levison, showed that a large number of the magnificent hickories in that extensive park were so seriously affected by this pernicious borer that it will be necessary to cut out many trees in order to save the remainder. This bark borer must be ranked as one of the most dangerous enemies of the hickory, since it has destroyed, in recent years, thousands of trees in central New York and is still continuing its nefarious work. The great trouble with outbreaks of this character is that many of the trees are practically killed before trouble is suspected. For example, an examination in September of many supposedly fine trees in Prospect park revealed the fact that numerous borers had entered the trees and that millions of grubs had nearly completed the girdling by running tortuous channels in the inner bark and sapwood. Aside from a few brown leaves here and there at the tips of branches killed by beetles feeding in the petioles and a few extremely inconspicuous fine borings scattered in the crevices of the bark, there was practically nothing externally to indicate the condition of affairs. This dark brown or black, rather stout, cylindrical beetle about 1/5 of an inch long invariably starts its gallery under a protecting scale of bark and owing to the regularity of the cracks in hickory, these hidden points of entry are usually in series one above another. To make matters even worse the obscure initial attack is very likely to occur about the middle or the upper portion of the trunk where observation is extremely difficult. The beetles begin their galleries the latter part of June or throughout July. At the time of our investigation many of the grubs were more than half grown, while a few had nearly attained full size.

There is only one thing to do in the case of a serious infestation such as that detailed above. All badly infested trees or portions of trees should be cut and the bark at least burned before the following April in order to prevent grubs now in the bark from maturing and changing to beetles which another season might continue the destructive work in previously uninfested trees. Thorough spraying of specially valuable trees the latter part of May or early in June with arsenate of lead used at the rate of 6 to 8 pounds to 50 gallons of water should be of considerable service in killing the beetles when they gnaw their way into the twigs and leaf stalks. It is possible that uninfested trees in a section where this pest is

known to be abundant could be protected to a large extent by liberal applications, the last of May, to the bark of the trunk and larger branches, of tree tanglefoot. The discovery in July or early August, of an attack on a previously uninfested tree is not necessarily hopeless, since it should be possible though somewhat expensive, by careful examination to locate most of the points of entrance and kill the beetles or recently deposited eggs (dependent upon the promptness with which operations are begun) by injecting carbon bisulfid or kerosene. This is simply an emergency treatment which might be tried to advantage in case of very highly prized trees.

LIST OF PUBLICATIONS OF THE ENTOMOLOGIST

The following is a list of the principal publications of the entomologist during the year 1909. 70 are given with title,[1] time of publication and a summary of the contents of each. Volume and page numbers are separated by a colon, the first superior figure gives the column and the second the exact place in the column in ninths: e. g. 73:1005[26] means volume 73, page 1005, column 2 in the sixth ninth, i. e. about two thirds of the way down.

Varieties of the Tussock Moth. Country Gentleman, Oct. 22, 1908, 73:1005[26]

Brief descriptive notices of the white marked tussock moth, Hemerocampa leucostigma Sm. & Abb., the hickory tussock moth, Halisidota caryae Harr., the well marked tussock moth, Hemerocampa definita Pack. and the old tussock moth, Notolophus antiqua Linn.

Prolificacy of Plant Lice. Commercial West (Minneapolis, Minn.), Jan. 30, 1909, 15:59

Original estimates of the possible prolificacy of the hop plant louse, Phorodon humuli Schrank.

Greenhouse Scale. Country Gentleman, Feb. 4, 1909, 64:104[35]

Remedial measures are given for Lecanium hesperidum Linn.

[1] Titles are given as published and in some instances they have been changed or supplied by the editors of the various papers.

Recent Importations of Brown Tail Moth in French Apple Seedlings. National Nurseryman, Feb. 1909, 17:46–47

General account of Euproctis chrysorrhoea Linn. with special reference to measures for preventing its obtaining a foothold in New York State.

Gall Midges of the Goldenrod. Ottawa Naturalist, Feb. 1909, 22: 244–49

Brief observations on the Cecidomyiid fauna of Solidago with a descriptive list of the galls and their inhabitants, some 35 species being noticed.

The Economic Status of the House-Fly. Economic Entomology Journal, Feb. 1909, 2:39–44

The evidence warrants our considering the house fly, Musca domestica Linn., as an important agent in the dissemination of typhoid fever, certain other grave intestinal disorders, tuberculosis and other serious diseases, especially in warmer climates.

Brown Tail Moth, Euproctis chrysorrhoea Linn. Economic Entomology Journal, Feb. 15, 1909, 2:80

Records the introduction into New York and other states of many winter nests of this insect with recent importations of French seedlings. The resistance of the caterpillars to fumigation with hydrocyanic acid gas is noted.

Oyster Scale. Country Gentleman, Feb. 18, 1909, 74:153[35]

Brief economic account of Lepidosaphes ulmi Linn.

Destroying the Clover Mite. Garden Magazine, March 1909, 9:124

Brief discussion of habits and measures for controlling Bryobia pratensis Garm.

Arsenate of Lead. Country Gentleman, March 11, 1909, 74:235[20]

Recommendations as to the amount of poison which should be used.

Monarch and Mimic. N. Y. State Educ. Dep't, Arbor Day Annual, 1909, p. 20–22

A popular account of the Monarch, Anosia plexippus Linn. and the Viceroy, Basilarchia archippus Cram.

Greenhouse Scale. Country Gentleman, April 1, 1909, 74:320[12]

A general descriptive account of Orthezia insignis Sig., with a discussion of control measures.

The Interpretation of Nature. Entomological Society of Ontario, 39th Rep't, 1909, p. 23–30

A popular lecture giving particular attention to various bark and wood borers, the elm leaf beetle, Galerucella luteola Mull., the snow-white linden moth, Ennomos subsignarius Hubn., the sugar maple borer, Plagionotus speciosus Say, the gipsy moth, Porthetria dispar Linn., the brown tail moth, Euproctis chrysorrhoea Linn., the codling moth, Carpocapsa pomonella Linn., the cigar case bearer, Coleophora fletcherella Fern., the blister mite, Eriophyes pyri Nal., several scale insects and the house fly, Musca domestica Linn.

The Economic Importance and Food Habits of American Gall Midges. Entomological Society of Ontario, 39th Rep't, 1909, p. 43–46

A summary account of the destructiveness and food habits of many species.

Pests of Chestnut Trees. Country Gentleman, April 8, 1909, 74: 344[23]

Brief economic accounts of the two lined chestnut borer, Agrilus bilineatus Weber, and of the chestnut timber worm, Lymexylon sericeum Harr.

Spraying. Country Gentleman, April 8, 1909, 74:346[7]

Brief discussion of the action of the lime-sulfur wash and of methods of spraying for codling moth.

Controlling Codling Moth. Country Gentleman, April 8, 1909, 74:348[12]

A summary statement of results obtained in Washington by modifying the method of spraying for Carpocapsa pomonella Linn.

What Ails Your Plants? Garden Magazine, May 1909, 9:221–25

A comprehensive spray calendar with formulas for the principal insecticides and fungicides.

Anthrenus verbasci Linn. Economic Entomology Journal, April 1909, 2:193

Record of continuous breeding in a closed jar containing dry corn for a period of seven years.

Spraying for the Codling Moth. N. Y. State Fruit Growers Ass'n Proc. 8th Meeting, 1909, p. 113–21

Summary of Professor Melander's discussion of western results in controlling Carpocapsa pomonella Linn.

For Codling Moth. Country Gentleman, April 22, 1909, 74:403[12]

Spray within a week or 10 days after the blossoms fall for Carpocapsa pomonella Linn.

Spray Pumps. Country Gentleman, April 22, 1909, 74:403[26]

The relative value of pressure, vermorel and bordeaux sprays is briefly discussed.

Spray Poisoning. Country Gentleman, April 22, 1909, 74:403[42]

Judicious spraying involves no danger to stock fed or feeding on the grass under the trees, though it is advised to wait 48 hours after the application.

Shade Tree Pests. Troy Press, May 5, 1909

General directions for the control of the elm leaf beetle, Galerucella luteola Mull., and the white marked tussock moth, Hemerocampa leucostigma Sm. & Abb.

Control of Household Insects. N. Y. State Mus. Bul. 129, p. 1–48, fig. 34 (Issued May 7, 1909)

Contents

Grape Blossom Midge. Grape Belt, May 18, 1909, p. 10

A detailed popular account of Contarinia johnsoni Sling., recording the rearing of the adult and making suggestions for the control of the pest.

Spruce Gall Aphis. Country Gentleman, May 20, 1909, 74:500[46]

Brief general account with a description of a new form of injury by Chermes abietis Linn. The latter proves to be Physokermes abietis work.

Cucumber Beetle. Country Gentleman, May 27, 1909, 74:525[12]

A brief discussion of methods for controlling the striped cucumber beetle, Diabrotica vittata Fabr.

Cabbage Worm. Country Gentleman, June 3, 1909, 74:548[43]

Brief discussion of remedies and preventatives for Pieris rapae Linn.

Insecticides and Fungicides. N. Y. State Mus. Educ. Dep't, Handbook 18, April 1909 (Issued June 5), p. 1–22

Gives directions for the preparation and use of the principal insecticides and fungicides.

Caterpillars. Country Gentleman, June 10, 1909, 74:572[16]

A discussion of the value of bands in protecting trees against tent caterpillars, Malacosoma americana Fabr.

Maple Gall. Country Gentleman, June 10, 1909, 74:572[25]

A brief economic account of Eriophyes quadripes Shim.

Codling Moth. Country Gentleman, June 10, 1909, 74:572[37]

A discussion of the essentials to successful spraying for Carpocapsa pomonella Linn.

Further Observations on Contarinia. Economic Entomology Journal, 2:257

The rearing of Contarinia johnsoni Sling. is recorded with observations upon its economic importance.

Bud Worm. Country Gentleman, June 17, 1909, 74:594[27]

Brief descriptive account giving control measures for this species, Tmetocera ocellana Schiff. and the associated case bearers.

An Army Worm Outbreak. Country Gentleman, June 24, 1909, 74:614[25]

Records an outbreak by Heliophila unipuncta Haw. at Oakdale, L. I. and gives remedial measures.

Plum Aphis–Rose Leaf Hopper. Country Gentleman, June 24, 1909, 74:616[11]

General economic account of aphids on plum and other fruit trees with a brief notice of the rose leaf hopper, Typhlocyba rosae Linn.

Plant Lice. Country Gentleman, July 1, 1909, 74:635[12]

Brief observations are given on plant lice with directions for their control.

Save Your Apple Crops from the Canker Worm. Poughkeepsie Evening Star, July 2, 1909, p. 8

A general discussion of Paleacrita vernata Peck with special reference to control measures.

Natural Enemies of Plant Lice. Grape Belt (Dunkirk, N. Y.) July 2, 1909, p. 8

A brief discussion of plant lice and their enemies on elms with observations on methods of control.

Sugar Maple Borer. Country Gentleman, July 8, 1909, 74:654[36]

A brief notice of Plagionotus speciosus Say with suggestions for its control.

Falling Leaves. Country Gentleman, July 8, 1909, 74:655[16]

A short notice of Chaitophorus aceris Linn. with observations on the dropping of leaves.

Controlling Hop Louse. Country Gentleman, July 8, 1909, 74:655[32]

The life history of Phorodon humuli Schrk. is briefly outlined and directions given for its control.

The Birch and Witch-Hazel Louse. Country Gentleman, July 8, 1909, 74:656[11]

The life history of Hamamelestes spinosus Shim. is discussed together with control measures. Directions are also given for controlling elm leaf beetle, Galerucella luteola Mull.

New Species of West Indian Cecidomyiidae. Entomological News, 1909, 20:299–302

The following new species were described: Asynapta mangiferae. Asphondylia attenuatata and Lobodiplosis spinosa.

Snow-White Linden Moth. Argus (Albany), Brooklyn Eagle,

Utica Observer, July 14, 1909; Plattsburg Star, July 13; Catskill Recorder, July 23

A general notice recording injuries in the Catskills by Ennomos subsignarius Hubn. and discussing causes. The desirability of protecting birds is emphasized.

Oak Leaf Miner. Country Gentleman, August 5, 1909, 74:734[34]

A brief descriptive and biologic account of Lithocolletes hamaryella Clem.

Squash Vines. Country Gentleman, August 12, 1909, 74:754[37]

A brief discussion of the squash vine borer, Melittia satyriniformis Hubn. and the striped cucumber beetle, Diabrotica vittata Fabr.

Tortoise Beetle. Country Gentleman, August 12, 1909, 74:755[24]

A short descriptive account of the golden tortoise beetle, Coptocycla bicolor Fabr.

Gipsy and Brown Tail Moth Work. Country Gentleman, August 12, 1909, 74:756[23]

A general review summarizing the accomplishments and pointing out the mportant phases of this work against Porthetria dispar Linn. and Euproctis chrysorrhoea Linn.

Additional Rearings in Cecidomyiidae. Economic Entomology Journal, August 1909, 2:286–93

Records the rearing of 40 species, 37 being briefly described as new. A new genus, Caryomyia, with Cecidomyia tubicola O. S. as type, was erected.

Scientific Notes. Economic Entomology Journal, August 1909, 2:306–7

The following species are noticed: The snow-white linden moth, Ennomos subsignarius Hubn., a number of the more injurious Aphididae and the brown tail moth, Euproctis chrysorrhoea Linn.

Cabbage Lice. Country Gentleman, August 19, 1909, 74:775[17]

A brief discussion of Aphis brassicae Linn. and methods for its control.

Unicorn Prominent. Country Gentleman, August 19, 1909, 74:775[26]

A brief descriptive account of Schizura unicornis Sm. & Abb.

Squash Bugs. Country Gentleman, August 19, 1909, 74:775[33]

A general economic account of Anasa tristis DeG.

Strawberry Grubs. Country Gentleman, August 19, 1909, 74:775[43]

Remedial measures are given for these pests.

Where this Year's Insects Came From. Garden Magazine, September 1909, 10:68–69

A general discussion of the causes of insect outbreaks with special reference to the excessive numbers of plant lice. A few of the more injurious or more interesting aphids are briefly noticed.

Lilac Borer. Country Gentleman, August 26, 1909, 74:803[17]

A brief economic discussion of Podosesia syringae Harris.

Probably Elm Leaf Beetle. Country Gentleman, August 26, 1909, 74:822[13]

A summarized account of Galerucella luteola Mull. with special reference to control measures.

Worst than Most Diseases. Country Gentleman, September 9, 1909, 74:859[21]

The characteristics of the San José scale, Aspidiotus perniciosus Comst. are given and spraying with a lime-sulfur wash is advised.

Cutworms in Corn. Country Gentleman, September 9, 1909, 74:859[25]

A general descriptive account of the corn ear worm or boll worm, Heliothis armiger Hubn.

The Sugar Maple Borer. Country Gentleman, September 9, 1909, 74:859[34]

A general account of Plagionotus speciosus Say with a discussion of remedies.

Apples Injured by Insects. Country Gentleman, September 9, 1909, 74:859[43]

A discussion of the causes producing deformed apples, aphids or plant lice, the tarnished plant bug, Lygus pratensis Linn. and the curculio injury being described.

A Caterpillar. Country Gentleman, September 16, 1909, 74:880[47]

A brief descriptive account of Basilona imperialis Drury.

Oak Caterpillar. Country Gentleman, September 23, 1909, 74:904[36]

A general descriptive account of Anisota senatoria Sm. & Abb.

Luminous Larvae. Country Gentleman, September 23, 1909, 74:907[35]

The half grown larva of Phengodes plumosa Oliv. is identified and several allied luminous forms, Phengodes laticollis Lec., Photuris pennsylvanica DeG. and Pyrophorus noctilucus Linn. are briefly noticed.

The Grain Weevil. Country Gentleman, September 23, 1909, 74:907[44]

The Angoumois moth, Sitotroga cerealella Oliv. is presumably the pest. A brief economic account is given of this species.

24th Report of the State Entomologist on Injurious and Other Insects of the State of New York. 1908. N. Y. State Mus. Bul. 134, 206p. 17 pl. 1909 (Issued Sept. 27)

Contents

A Diseased Elm Tree. Country Gentleman, October 7, 1909, 74:951[42]

Directions are given for controlling the elm leaf beetle, Galerucella luteola Mull., the possible cause of the trouble.

Insects and Legislation. Economic Entomology Journal, 2:342–45

A summarized discussion of legislation relating to insects.

ADDITIONS TO COLLECTIONS, OCT. 16, 1908–OCT. 15, 1909

The following is a list of the more important additions to the collection.

DONATION

Hymenoptera

Sphecodes fragariae Ckll., S. sophiae Ckll. var. Halictus scrophularia Ckll., Augochlora neglectula Ckll., Andrena prunorum gilletti Ckll., Panarginus cressoniellus Ckll., Feb. 16, Prof. **T. D. A. Cockerell,** Boulder, Col.

Steniolia obliqua Say, Trypoxylon frigidum Sm., Thyreopus latipes Sm., Andrena geranii Rob., A. porterae Ckll., A. prunorum Ckll., Nomada collinsiana Ckll., Osmia fulgida Cress., Dianthidium parvum Cress., Megachile pugnata Say, Ceratina neomexicana Ckll., Melissodes obliqua Say, M. agilis Cress., Anthophora simillima Cress., Nov. 12, **S. A. Rohwer,** Boulder, Col.

Xylocopa virginica Dru., large carpenter bee, adult, June 28, Miss **M. A. Batly,** Schaghticoke

Agapostemum viridula Fabr., solitary digger bee, adult, July 9, **Leslie Crane**, Rutland, Vt. Through Doubleday, Page & Co., New York

Thalessa atrata Fabr., black long sting, adult, June 24, **O. D. Patterson**, Richburg

Rhodites rosae Linn., rose bedegar, gall on rose, July 10, Miss **L. M. Hasbrouck**, Ogdensburg

Andricus clavula Bass., oak tip gall on white oak, October 23, **H. L. Frost & Co.,** White Plains

Lophyrus lecontei Fitch, pine sawfly, larvae on pine, July 31, Miss **Josephine Goldmark,** St Huberts

Emphytus cinctus Linn., coiled rose slug, larva on rose, January 30, **Percy L. Huested,** Rochester

Amauronematus azaleae Marlt., larvae on azalea, June 8, **J. A. Thomson,** Rochester

Kaliosysphinga ulmi Sund., elm leaf miner, larvae on elm, June 7, **J. H. Livingston**, Tivoli. Same, June 17, **J. A. Thomson,** Rochester

Lygaeonematus erichsonii Hart., larch sawfly, larvae on larch, June 28, Miss **Rhoda Thompson,** Ballston Spa

Tremex columba Linn., pigeon Tremex, adult, September 13, **D. D. Hoover,** Syracuse. Same, adult on maple, September 22, **R. Closson,** Addison

Coleoptera

Hylesinus aculeatus Say, ash bark beetle, adults, eggs and larvae on ash, May 18, **Barton & Spooner Co.,** Cornwall. Through Forest, Fish and Game Commission

Eccoptogaster quadrispinosus Say, hickory bark borer, larvae on hickory, October 28, **J. J. Levison,** Brooklyn; Same, adult and larvae on hickory, September 17, **D. D. Hoover,** Syracuse

Pomphopoea sayi Lec., Say's blister beetle, adults on rose, June 28, **Paul Roach,** Quaker Street

Epicauta? puncticollis Mann., blister beetle, adults, July 24, **E. B. Peterson,** Chatham. Through T. F. Niles

Disonycha pennsylvanica Ill., adult on apple trees, March 31, **E. B. Norris,** Sodus

Galerucella luteola Mull., elm leaf beetle, larvae on elm, July 12, **George Zabriskie,** Nissequogue, St James, L. I. Same, July 8, Mrs **H. Fletcher Fordham,** Greenport, L. I. Through Forest, Fish and Game Commission. Same, July 14, **J. H. Fish,** Greenport, L. I. Same, larvae and pupae, August 18, Mrs **Albert Delafield,** Greenport, L. I. Same, July 23, **P. B. McKensie,** Northport, L. I. Same, July 26, **John O. Van Clefe,** Oakdale. Same, August 5, **E. M. White,** Sag Harbor, L. I. Same, August 24, **C. L. Simpson,** Amsterdam

Trichius affinis Gory, adult, July 15, Mrs **W. S. Miller,** Boonville

Euphoria inda Linn., flower beetle, adults, September 21, **Frederick Chatfield,** Troy

Macrodactylus subspinosus Fabr., rose beetle, adults, June 19, **G. C. Schaible,** Brooklyn. Same, June 21, **F. Lindquist,** Brooklyn

Chalcophora liberta Germ., smaller flat-headed pine borer, adult, June 3, Miss **Eliza S. Blunt,** New Russia

Phengodes plumosa Oliv., larva, August 9, Ridgefield, Conn. Through Country Gentleman

Asaphes decoloratus Say, larvae killed by a fungus, Cordyceps aciculariS Rav. (C. carolinensis B. & R. Ravenel's exsiccati) November 27, **C. W. Nash,** Toronto, Canada

Alaus oculatus Linn., owl beetle or eyed elater, adult, June 23, Mrs **J. D. Patterson,** Pattersonville

Silvanus surinamensis Linn., saw-toothed grain beetle, adult in flour, April 20, **J. A. Hepworth,** Marlborough

Anatis ocellata Linn., larva, pupa and adult on apple, July 1, **Milo F. Winchester,** South Amenia

Nomius pygmaeus Dej., August 21, **S. B. Ferris,** Upper Saranac

Diptera

Rhagoletis pomonella Walsh, many adults on apple, September 10, **C. E. Brisbin,** Schuylerville

R. suavis Loew, adult on apple, September 10, **C. E. Brisbin,** Schuylerville

Bombyliomyia abrupta Wied., adult, August 25, **L. F. Baldwin,** Albany

Numerous Cecidomyiid galls were received from Miss **Cora H. Clarke,** Boston and Magnolia, Mass. and a number of new species reared from the material contributed. [*See* Econ. Ent. Jour. 1909, 2:286–93]

A number of Cecidomyiids were received during the season from Mr **C. P. Alexander,** Johnstown

Rhopalomyia hirtipes O. S., numerous subterranean galls September 2, 1909 from Miss **F. A. Stebbins,** through Dr **George Dimmock,** Springfield, Mass.

Sackenomyia packardi Felt, larvae in willow shoots, April 15, **Winthrop Packard**, Canton, Mass.

Lasioptera tripsaci Felt, adults reared from Tripsacum dactyloides, Texas, **F. M. Webster,** Washington, D. C.

Cecidomyia opuntiae Felt, reared from Opuntia leaves, **George V. Nash,** Bronx Park, New York

A number of other gall midges have been received from various parties and will be duly acknowledged in subsequent descriptions or discussions of the species.

Lepidoptera

Sphecodina abbotii Swain, Abbot's sphinx, larvae on woodbine, July 30, Miss **Emma S. Call**, Northport. Same, larvae, August 12, Mrs **A. Openhym,** St Huberts

Deilephila lineata Fabr., white lined sphinx, moth, September 11, **Bell & Smith Nursery Seed Co.,** Castleton

Sphinx drupiferarum Sm. & Abb., plum sphinx, adult, June 7, **Ezra Shults,** Fort Plain

Sphinx chersis Hubn., ash sphinx, adult, July 26, **H. H. Fitch,** West Winfield

Halisidota caryae Harr. on elm, August 18, Mrs **Albert Delafield,** Greenport

Heliophila unipuncta Haw., army worm, larvae, June 17, **George P. Slade,** (New York city) Oakdale

Heliothis armiger Hubn., corn worm, larvae on corn, October 19, Dr **C. W. Frispell,** Shelter Island Heights

Melalopha inclusa Hubn., poplar tent maker, larvae on poplar, August 2, **Jarvis W. Baxter,** Adams Corners

Notolophus antiqua Linn., dark or rusty tussock moth, larvae, June 29, **E. Dillingham,** Ogdensburg

Tolype velleda Stoll., larch lappet, larva, July 23, **Charles Burbank,** LaGrangeville

Paleacrita vernata Peck, spring canker worm, larvae on apple trees, May 31, **Ernest Emans,** LaGrangeville

Alsophila pometaria Harr., fall canker worm, adults, Nov. 30 & Dec. 2, **Augustus Floyd,** Moriches

Acrobasis feltella Dyar, larvae on hickory, June 12, Mrs **A. M. A. Jackson,** Warner

Archips cerasivorana Fitch, ugly nest cherry worm, nest, July 17, **P. L. Huested,** Blauvelt

Tortrix fumiferana Clem., spruce bud worm, adults July 21, **G. A. Bailey,** Syracuse. Same, July 22, **Richard Lohrmann,** Utica

Coleophora fletcherella Fern., cigar case bearer, larvae on apple, June 16, **F. A. Fitch,** Randolph

Coleophora limosipennella Dup., European elm case bearer' cases and adults, August 4, **John O. VanClefe,** Oakdale

Antispila nyssaefoliella Clem., larvae and work on pepperidge, September 25, **Roy Latham,** Orient Point

Corrodentia

Psocus salicis? Fitch, nymph in house, November 4, **S. H. Burnham,** Vaughn

Hemiptera

Enchenopa binotata Say, 2-spotted tree hopper, egg masses on bittersweet, August 25, **Paul Cook,** Troy

Belostoma americanum Leidy, electric light bug, adult, October 26, **J. R. Gillett,** Kingston

Leptobyrsa explanata Heid., lace-winged bug, larvae on Rhododendron, June 8, **J. A. Thomson,** Rochester. Same, adult, July 5, **P. L. Huested,** Blauvelt

Aelyrodes citri Riley & Howard, white fly on orange leaf, June 15, Florida. Through J. F. O'Mara, Cornwall

Phyllaphis fagi Linn., woolly beech leaf aphis, adults on beech, May 15, **J. H. Livingston,** Tivoli

Chermes strobilobius Kalt., spruce gall aphid, galls on spruce, May 3, **P. L. Huested,** Blauvelt

C. pinicorticis Fitch, pine bark aphid, adults on pine, March 30, Mrs **George W. Ray,** Norwich. Same, adults and eggs on balsam, September 11, **E. & W. G. Breithaupt,** Phoenicia. Same, adults on pine, September 14, **J. H. Livingston,** Tivoli

C. abietis Linn., spruce gall aphid, galls on spruce, March 8, **William B. May,** Irvington. Same, August 14, **C. R. Pettis,** Lake Clear Junction

Phylloxera caryaecaulis Fitch, hickory gall aphid, adults and young on hickory, June 30, **F. S. Witherbee,** Port Henry

Pemphigus vagabundus Walsh, galls on poplar, July 30, **Henry Ackley,** Cambridge. Same, August 11, **C. H. McCullock,** Schenectady

P. populi-transversus Riley, galls on poplar, July 30. **Henry Ackley,** Cambridge

Colopha ulmicola Fitch, cockscomb elm gall on elm, July 19, **W. C. Donnan,** LeRoy

Schizoneura americana Riley, woolly elm leaf aphid, adults on elm, July 6, **John Allis** jr, Rye. Through H. W. Niles. Same, June 25, Mrs **H. D. Graves,** Ausable Forks

Lachnus dentatus LeBaron, adult on willow, September 23, **Bloodgood Nurseries,** Flushing. Through Theodore Foulk

Callipterus ulmifolii Monell, elm leaf aphid, badly infested leaves of elm, June 29, **H. G. Jones,** Dunkirk

Psyllid, June 17, **J. A. Thomson,** Rochester

Chrysomphalus dictyospermi Morg., Morgan's scale, all stages, abundant and causing serious damage on palm, December 28, **L. Menand,** Albany

Eulecanium tulipiferae Cook, tulip tree scale, adults on tulip, September 14, **J. H. Livingston,** Tivoli

Coccus hesperidum Linn., soft scale, young and adults on begonia, December 12, **H. VanAlstyne,** Chatham Center

Phenacoccus acericola King, false maple scale, young on maple, November 10, **Arthur Dummett,** Mt Vernon

Pulvinaria vitis Linn., cottony maple scale, adults on maple, June 21, **J. A. Thomson,** Rochester

Gossyparia spuria Modeer, elm bark louse, adult on elm, June 21, **Thomas J. Riley,** Catskill. Through Percy L. Huested

Aulacaspis rosae Sandbg., rose scale, eggs, on blackberry, April 22, Miss **Francis Foley,** Cornwall

Aulacaspis pentagona Targ., West Indian peach scale on Prunus pseudo-cerasus from New Rochelle through T. F. Niles, State Department of Agriculture

Chionaspis pinifoliae Fitch, pine leaf scale on spruce, January 5, **Arthur Gibson,** Ottawa, Canada. Same, on Austrian pine, September 11, **Theodore Foulk,** Flushing

Aspidiotus forbesi John., on apple, November 6, **Charles A. Richmond,** East Aurora

A. ostreaeformis Curt. on apple, pear and plum, October 29, **Thomas Cunningham,** Vancouver, B. C.

A. perniciosus Comst., San José scale, adults on apple, April 10, **A. C. Burt,** Owego. Same, June 1, **A. J. Smith,** Rexford Flats

Draeculacephala reticulata Sign., Deltocephalus sonorus Ball, D. flavicosta Stal., D. nigrifrons Forbes, D. obtectus O. & B., D. inimicus Say, Xestocephalus pulicarius VanD., X. brunneus VanD., Eutettix strobi Fitch, E. stricta Ball, Acinopterus acuminatus VanD., Phlepsius spatulatus VanD., Athysanus exitiosus Uhler, Platymetopius near loricatus VanD., Scaphoideus consors Uhler, typical, S. immistus Say, Typhlocyba vulnerata Fitch, T. comes Say, T. sp. (near trifasciata), T. comes var. vitis Harr., T. tricincta Fitch, Oliarus complectus Ball, Pissonotus delicatus VanD., P. basalis VanD., P. ater VanD.?, Liburnia pellucida Fabr.?, L. consimilis VanD., Empoasca mali LeBaron, E. flavescens Fabr., E. sp. new, Balclutha abdominalis VanD.?, Nysius minutus Uhler, Reuteroscopus ornatus Reut., Atomoscelis seriatus Reut.?. From Mrs **P. L. Windsor,** Austin, Tex. Very kindly determined by E. P. VanDuzee of Buffalo

Orthoptera

Oecanthus niveus DeG., snowy tree cricket, eggs on raspberry, April 3, **Lansing Appleby,** Clarksville

Periplaneta americana Linn., American cockroach, adult, April 10, **J. A. Thompson,** Syracuse

Mantis religiosa Linn., European Mantis, egg mass, February 15, **Louis H. Adams,** Canandaigua

Thysanura

Achorutes nivicola? Fitch, very abundant on sand, April 8, **Jackson & Perkins,** Newark

Isoptera

Termes flavipes Linn., white ants, adults, April 19, **M. W. Van-Denburg,** Mt Vernon

EXCHANGE

Hymenoptera

Tucker, E. S., Manhattan, Kan. Trypoxylon carinifrons Fox, Polistes minor Beauv.

Coleoptera

Berosus subsignatus Lec., Psyllobora taedata Lec. Conotelus stenoides Murr., Scaptolenus lecontei Salle, Photinus benignus Lec., Lobetus abdominalis Lec.

Diptera

Beskia aelops Walk., Sturmia distincta Wied., Sarcophaga assidua Walk., S. quadrisetosa Coq., Pseudopyrellia comicina Fabr., Pachycerina clavipennis Coq.

Lepidoptera

Chlorochlamys phyllinaria Zell., Loxostege mancalis Led., Lineodes integra Zell., Crambus teterrellus Zink., C. mutabilis Clem., Saluria tetradella Zell., Pterophorus inquinatus Zell., Platynota nigrocervina Wals., Anaphora popeanella Clem.

PURCHASE

House fly, Musca domestica Linn. (x 30), model
Malarial mosquito, Anopheles, dissectible model of head. (x 800)
House mosquito, Culex pipiens Linn., dissectible model of head. (x 800)
The above from **The Kny-Scheerer Co.,** New York city

INSECT COLLECTIONS

Summary statement

The total number of insect specimens in the collections approximates 150,000 distributed about as follows:

Orthoptera	1 770	Lepidoptera	31 624
Odonata	987	Diptera	24 953
Neuroptera	1 001	Coleoptera	40 267
Hemiptera	12 113	Hymenoptera	11 917

The alcoholic material belonging in various groups amounts to some 25,000 specimens.

The Hill collection, included in the above estimate, comprises some 10,000 specimens of Lepidoptera.

The Lintner collection, also included in the above enumeration, comprises some 19,228 specimens, distributed as follows: Orthoptera 91; Odonata 241; Neuroptera 230; Hemiptera 1377; Lepidoptera 10,182; Diptera 978; Coleoptera 5002; Hymenoptera 1126.

There are on exhibition some 5746 specimens, distributed as follows: Orthoptera 146; Odonata 31; Neuroptera 43; Hemip-

tera 1036; Lepidoptera 1500; Diptera 401; Coleoptera 2000; Hymenoptera 588. There are also on exhibition 51 photographs, 57 illustrations, 17 models, 14 biological groups and 38 special mounts.

The collections contain some 700 types and about 1500 figured specimens.

INSECT TYPES IN NEW YORK STATE MUSEUM

The following list of insect types is placed on record for the convenience of students and also as a tangible evidence of the growing value of the New York State collections. The court of ultimate appeal in the identification of a species is found in the type — frequently unique. A knowledge of the whereabouts of all such specimens is therefore very important to the systematic worker. The long list of the writer's Cecidomyiid types is not included, since it is planned to indicate the location of these in the monograph on this group, now almost complete.

HYMENOPTERA

Eniscopilus arcuatus *Felt*
E. appendiculatus *Felt*
Ophion abnormum *Felt*
O. ferruginipennis *Felt*
Genophion gilletti *Felt*
G. coloradensis *Felt*

DIPTERA

Culicelsa auroides *Felt*
Culicada abfitchii *Felt*
C. abserratus *Felt & Young*
C. cinereoborealis *Felt & Young*
C. fitchii *Felt & Young*
C. lazarensis *Felt & Young*
C. onondagensis *Felt*
C. subcantans *Felt*
Culiseta absobrinus *Felt*
C. magnipennis *Felt*
Culex brittoni *Felt*
Corethra karnerensis *Felt*
C. lintneri *Felt*
C. fuliginosus *Felt*
Sayomyia rotundifolia *Felt*
S. hudsoni *Felt*
Myzomyia mangyana *Banks* (cotype)
Worcesteria grata *Banks* (cotype)

MYCETOPHILIDAE

Sciara agraria *Felt*
S. caldaria *Lint.*
S. coprophila *Lint.*
S. multiseta *Felt*
S. pauciseta *Felt*
S. prolifica *Felt*

CECIDOMYIIDAE[1]

Dasyneura leguminicola *Lint.*
Aphidoletes cucumeris *Lint.*
Contarinia setigera *Lint.*

[1] There are in addition numerous recently described species which will be fully noticed in a forthcoming publication.

STRATIOMYIDAE

Zabrachia polita *Coq.* (cotype)

EMPIDIDAE

Roederioides juncta *Coq.* (cotype)

ASILIDAE

Dasyllis cinerea *Back.* (cotype)
Cyrtopogon marginalis *Loew* (homotype)
C. lyratus *O. S.* (homotype)

DOLICHOPODIDAE

Dolichopus marginatus *Ald.*

PHORIDAE

Aphiochaeta agarici *Lint.*
A. albidihalteris *Felt*

SYRPHIDAE

Syrphus montivagus *Snow*

TACHINIDAE

Pachyophthalmus floridensis *Town.*
Epigrimyia lucens *Town.*
Spallanzania hebes *Fall.*
Hilarella decens *Town.*
Pegomyia betarum *Lint.*
P. vicina *Lint.*

LEPIDOPTERA

Kricogonia lanice *Lint.*
Chlorippe cocles *Lint.*
Rusticus lotis *Lint.*
Euphyes osceola *Lint.* ?
Thanaos
- ausonius *Lint.*
- icelus *Lint.* ?
- lucilius *Lint.* ?
- naevius *Lint.*
- pacuvius *Lint.* ?
- petronius *Lint.*

Sphinx insolita *Lint.*
Lapara pineum *Lint.*
Hadena hillii *Grt.*
Melanoporphyria immortua *Grt.*
Tarache terminimaculata *Grt.*
Catocala pretiosa *Lint.*
Xanclognatha inconspicualis *Grt.*
Phaeocyma umbrina *Grt.*
Cerura candida *Lint.*
C. occidentalis *Lint.* ?
Harpyia aquilonaris *Lint.*
Tephroclystis palpata *Pack.*
Venusia perlineata *Pack.*
Euchoeca exhumata *Pears.* (cotype)
Eustroma mucronata *Peck* (disjunctaria *Pack.*)
Racheospila saltusaria *Hulst*
Semiophora badicollis *Grt.*
Agrotis badinodis *Grt.*
Anytus planus *Grt.*
Xylina unimoda *Lint.*
X. lepida *Lint.*
Calocampa nupera *Lint.*
Cucullia matricariae *Streck.*
C. laetifica *Lint.* ?
C. speyeri *Lint.* ?
C. serraticornis *Lint.* ?
Gortyna impecuniosa *Grt.*
Epiglaea venustula *Grt.*
Ipimorpha pleonectusa *Grt.*
Macaria mendicata *Hulst*
Enypia venata *Grt.*
Alcis metanemaria *Hulst*
Lychnosea helviolaria *Hulst*
Therina somniaria *Hulst*
Gonodontis lentaria *Hulst*
Azelina atrocolorata *Hulst*
Callizzia amorata *Pack.*
Cossus centerensis *Lint.*
C. undosus *Lint.*
Prionoxystus reticulatus *Lin'.*
P. querciperda *Fitch*
Hepialus furcatus *Grt.*

HEMIPTERA

Micrutalis (Tragopa) dorsalis *Fh.*
Glossonotus (Thelia) crataegi *Fh.*
Heliria scalaris *Fair.* (Telamona fagi *Fh.*)
Telamona unicolor *Fh.*
T. unicolor *Fh.* fasciata *Fh.*
T. concava *Fh.*
T. coryli *Fh.*
T. coryli *Fh.* tristis *Fh.*
T. querci *Fh.*
T. reclivata *Fh.*
Cyrtolobus (Cyrtosia) fenestratus *Fh.*
C. (Smilia) castaneae *Fh.*
C. (Smilia) querci *Fh.*
C. (Smilia) subsp. guttata *Fh.*
Archasia galeata *Linn.* (Smilia auriculata *Fh.*)
Microcentrus (Uroxiphus) caryae *Fh.*
Cixius pini *Fh.*
Myndus (Cixius) impunctatus *Fh.*
Stenocranus (Delphax) dorsalis *Fh.*
Liburnia (Delphax) arvensis *Fh.*
Lamenia (Poeciloptera) vulgaris *Fh.*
Aphrophora (Lepyronia) saratogensis *Fh.*
Clastoptera obtusa *Say* (testacea *Fh.*)
Clastoptera obtusa *Say* (pini *Fh.*)
C. obtusa *Say* (pini *Fh.*) subsp. flavicollis *Fh.*
C. obtusa *Say* (pini *Fh.*) subsp. cincticollis *Fh.*
C. proteus *Fh.* subsp. maculicollis *Fh.*
C. proteus *Fh.* subsp. nigricollis *Fh.*
Bythoscopus (Athysanus) variabilis *Fh.*
B. (Athysanus) variabilis *Fh.* abietis *Fh.*
B. (Athysanus) fenestratus *Fh.*
B. (Athysanus) minor *Fh.*
B. (Athysanus) fagi *Fh.*
B. (Athysanus) nigrinasi *Fh.*
Pediopsis trimaculata *Fh.*
P. viridis *Fh.*
Idiocerus lachrymalis *Fh.*
I. alternatus *Fh.*
Tettigonia tripunctata *Fh.*
Draeculacephala (Aulacizes) novaeboracensis *Fh.*
Helochara communis *Fh.*
Eucanthus acuminatus *Fabr.* (Evacanthus orbitalis *Fh.*)
Gypona geminata *Osb.*
Penthimia americana *Fh.*
Paramesus (Acocephalus) vitellinus *Fh.*
Platymetopius obscurus *Osb.* (cotype)
P. augustatus *Osb.*
P. fulvus *Osb.*
Deltocephalus (Amblycephalus) sayi *Fh.*
D. (Amblycephalus) melsheimeri *Fh.*
Scaphoideus opalinus *Osb.*
Athysanus (Amblycephalus) curtisii *Fh.*
Eutettix (Bythoscopus) strobi *Fh.*
Phlepsius (Jassus) fulvidorsum *Fh.*
Chlorotettix (Bythoscopus) tergata *Fh.*
C. (Bythoscopus) unicolor *Fh.*
Typhlocyba (Erythroneura) vulnerata *Fh.*
T. (Erythroneura) comes *Say var.* vitis *Fh.*
Aphis gladioli *Felt*
Rhopalosiphum (Aphis) berberidis *Fh.*
Nectarophora (Aphis) rudbeckiae *Fh.*
Schizoneura lanigera (Eriosoma pyri *Fh.*)
Pemphigus (Eriosoma) imbricator *Fh.*

COCCIDAE

Halimococcus lampas *Ckll.*

Coccus diversipes *Ckll.* (part of type)

ALEYRODIDAE

Aleyrodes betheli *Ckll.* (MS) (part of type)

EPHEMERIDAE

Siphlonisca aerodromia *Nedhm.*

Potamanthus inequalis *Nedhm*

ADDITIONAL LIST OF ADIRONDACK INSECTS

BY D. B. YOUNG

July 20 to August 10, 1909, found the writer enjoying a vacation at Speculator, N. Y., a village with good accommodations, located in the Adirondacks at the foot of Lake Pleasant. The romantic and delightful scenery appeals to one's love of the beautiful, while from an entomologist's point of view the great diversity of plant and insect life of mountain and valley offers exceptional opportunity for collecting many rare and interesting forms. We were particularly impressed by the large representation of Hemiptera in that section and resolved to make a partial collection of the species to be found there and such insects of other orders as might attract our attention. The limited time at our disposal prevented this collection from being as complete as we could wish but the following list will give some idea of the rare forms to be met with in this region.

The Hemiptera were submitted to E. P. VanDuzee, who very kindly made the identifications in that order. Of the 67 species submitted, 25 were new to the State collection. Among new or rare forms in other orders 15 were taken, as well as many others included in the list to preserve the records and make additions to the Adirondack lists already published.

Species marked with a dagger are new to the State collection; those with a star are not in the Adirondack list of Hemiptera in the 20th Report of the State Entomologist.

Hymenoptera

Pemphredon concolor *Say*
Psithyrus ashtoni *Cress.*
Pristiphora identidem *Nort.*
Dolerus aprilis *Nort.*
Strongylogaster pinguis *Nort.*
Harpiphorus articulatus *Nort.*
Emphytus inornatus *Say*
Tenthredo grandis *Nort.*

Coleoptera

†Coeliodes nebulosus *Lec.*
Pseudanthonomus crataegi *Walsh*
†Myodites *sp.*
Anaspis flavipennis *Hald.*
A. rufa *Say*
Phyllobrotica decorata *Say*
Melasoma scripta *Fabr.*
Saperda vestita *Say*
†Leptura biforis *Newm.*
Onthophagus hecate *Panz.*
†Elater hepaticus *Melsh.*
†Cleis picta *Rand.*

Diptera

†Dixa clavulus *Will.*
†Platyura *sp.*
†Sciophila
†Pangonia rasa *Loew*
†Chrysopa eucera *Loew*
C. hilaris *O. S.*

Tabanus reinwardtii *Wied.*
Chrysophila quadrata *Say*
Leptogaster flavipes *Loew*
Dasyllis sacrator *Walk.*
Asilus annulatus *Will.*
Laphria sericea *Say*
†Dolichopus pachycnemus ? *Loew*
D. grata *Loew*
D. detersus *Loew*
†Gymnopternus flavus *Loew*
Chrysotus discolor *Loew*
†Hybos slossonae *Coq.*
†Syneches *sp.*
†Syndyas polita *Loew*
†Leptopeza compta *Ccq.*
Trineura aterrima *Fabr.*
†Pipiza pulchella *Will.*
Mesogramma marginata *Say*
Zodion fulvifrons *Say*
Parallelomma varipes *Walk.*
Tetanocera plebeja *Loew*
Sapromyza fraterna *Loew*
S. lupulina *Fabr.*
Tephritis albiceps *Loew*
Sepsis violacea *Meig.*
Loxocera pectoralis *Loew*
Chyliza notata *Loew*
Meromyza americana *Fitch*
Chlorops assimilis *Macq.*
Elachiptera costata *Loew*
Drosophila amoena *Loew*

Lepidoptera

Pieris napi *Linn.*
Petrophora abrasaria *H.S.*
Cleora pampinaria *Guen.*
Pyrausta fumalis *Guen.*
Scoparia basalis *Walk.*
Crambus albellus *Clem.*

Hemiptera

Lygaeidae

*†Nysius ericae *Schill.*
*†Geocoris bullatus *Say*
*Lygaeus kalmi *Stal.*

Capsidae

Trygonotylus ruficornis *Fall.*
*†Resthenia insignis *var. Say*
Neurocolpus nubilus *Say*
Phytocoris eximius *Reut.*
Collaria meilleuri *Prov.*
*†Paracalocoris colon *Say*
*†Lygidae rubecula *Uhl. var* obscura *Reut.*
Lygus pabulinus *Linn.*
*†L. belfragei *Reut.*
*†L. vitticollis *Reut.*
L. invitus *Say*
L. hirticulus *Uhl.*
Hyaliodes vitripennis *Say*
Ilnacora malina *Uhl.*
Pilophorus amoenus *Uhl.*
*†Macrolophus separatus *Uhl.*[1]
*†Mecomma ambulans *Fall.*[2]
Stiphrosoma stygica *Say*
*†Labops burmeisterii *Stal.*[3]
Orthotylus; specimen too immature for identification
Plagiognathus obscurus *Uhl.*
*†P. *sp.*
*Onychumenus decolor *Fall.*

Membracidae

Campylenchia curvata *Fabr.*

Fulgoridae

*Cixius pini *Fitch*
C. stigmatus *Say*
*†Stenocranus felti *VanD.*[4]
Laccocera vittipennis *VanD.*
Liburnia pellucida *Fabr.*
L. lutulenta *VanD.*
*L. arvensis *Fitch*

[1]This species is accredited to the western states in Uhler's list.
[2]Mr VanDuzee states that he has seen but three specimens of this species.
[3]This is the first time this insect has been taken in America so far as we know. It has been recorded from Kamtschatka.
[4]This species is new to New York State.

Cercopidae

*†Aphrophora signoreti *Fitch*
Philaenus lineatus *Linn.*
*†P. spumarius *Germ*
Clastoptera obtusa *Say*

Tettigonidae

Diedrocephala teliformis *Walk.*
Eucanthus acuminatus *Fabr.*
Draeculacephala noveboracensis *Fitch*

Bythoscopidae

Idiocerus lachrymalis *Fitch*
I. provancheri *VanD.*
Agallia novella *Say*
A. quadripunctata *Prov.*

Jassidae

*Platymetopius frontalis *VanD.*
Deltocephalus configuratus *Uhl.*
D. minki *Fieb.*
D. sayi *Fitch*
D. sylvestris *O.&B.*
*†D. near sylvestris 3 ex. undet.
*†D. miscellus *Ball*
Specimen too immature for certain identification
Athysanus anthracinus *VanD.*
*†A. infuscatus *G.&B.*
*†A. new *sp.* near relativus
*†A. instabilis *VanD.*
*†Thamnotettix belli *Uhl.*
*†Cicadula lepida *VanD.*[1]
*Eugnathodus abdominalis *VanD*

Corrodentia

Psocus *sp.* near hageni
Peripsocus modidus *Hag.*
P. permadidus *Hag.*
Caecilius aurantiacus *Hag.*

Typhlocybidae

Dicraneura communis *Gill.*
Empoasca atrolabes *Gill.*
*E. mali *LeBaron*
Typhlocyba rosea? *Linn.*
*†T. lethierryi *Edw.*[2]
*†Alebra *n.sp.*

Mallophaga

†Trichodectes setosus *Gieb.*? on porcupine

Psyllidae

*†Livia vernalis *Fitch*
Psylla; two species not identified

Neuroptera

†Conwentzia hageni *Banks*[3]

---

[1]A rare form which Mr VanDuzee has not seen since he described it, many years ago.

[2]Gillette writing of this species in 1898 states the only native specimens that he has seen are from Michigan and Iowa. The form closely resembles T. r o s e a Linn.

[3]This species was described in 1906. The only records at hand show that it has been taken at Sea Cliff, L.I., Washington, D. C., Virginia and West Virginia.

EXPLANATION OF PLATES

PLATE I

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Fly vivarium. Photo, October 1909

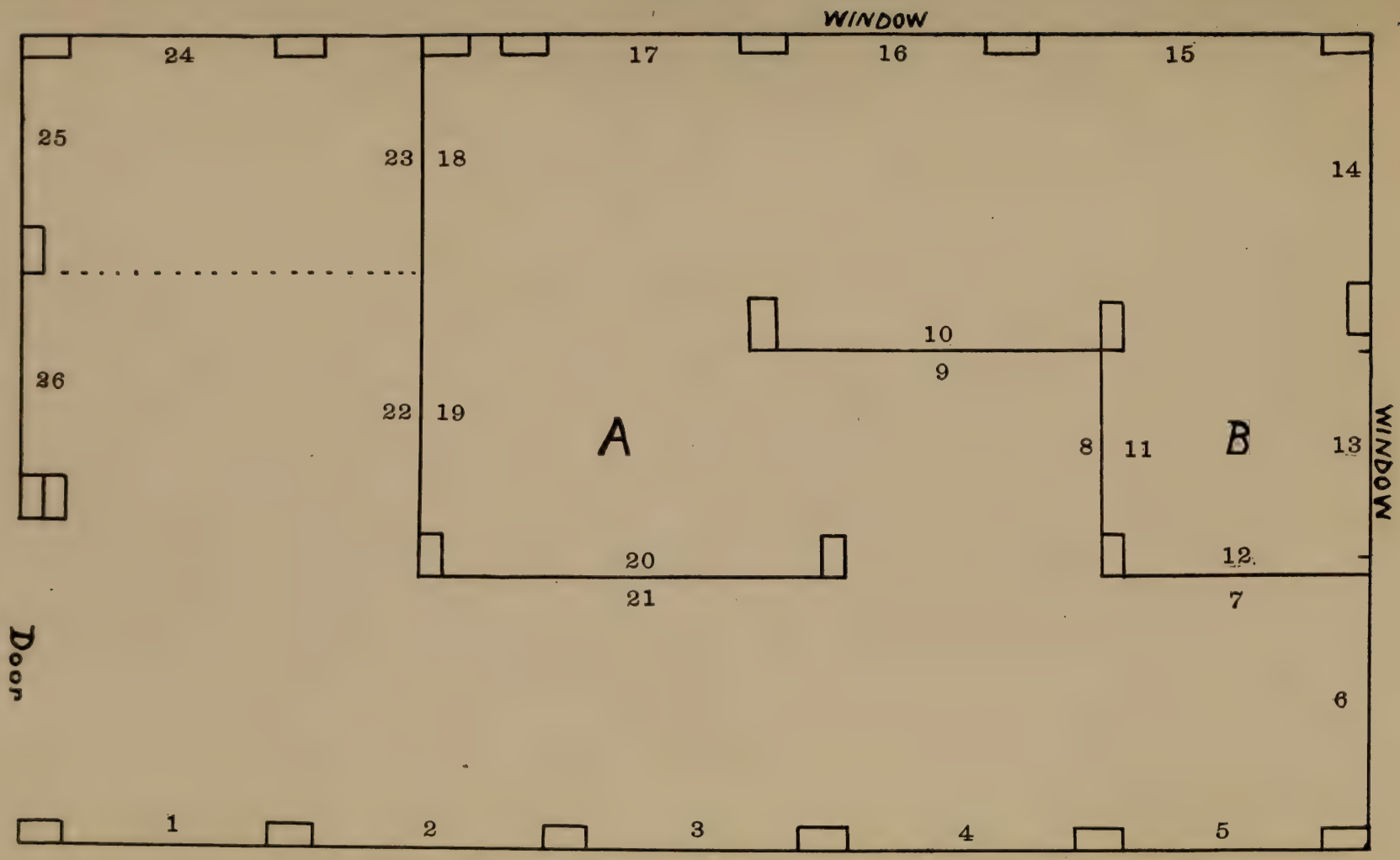
Plate 1

Fly vivarium

PLATE 2

Plan of fly vivarium

Plate 2



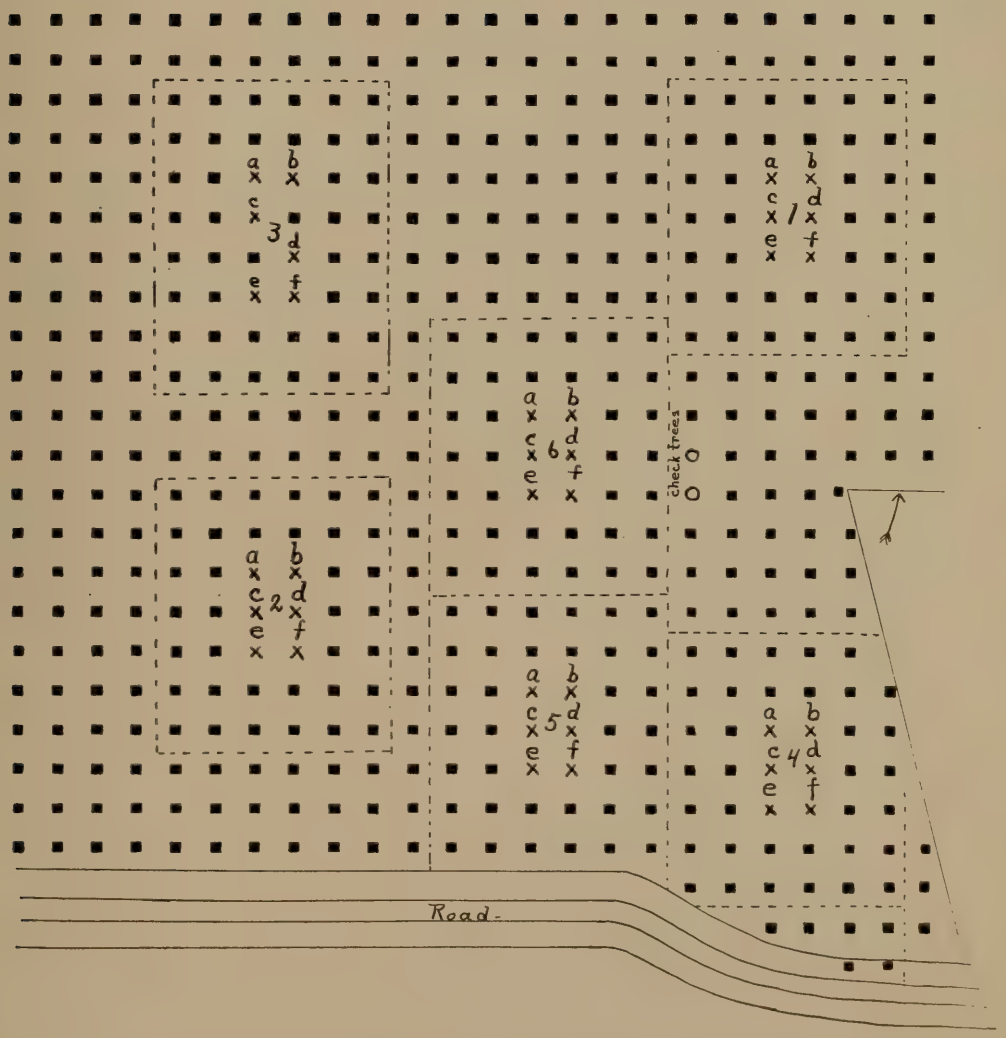
Fly vivarium, ground plan

PLATE 3

131

Plan of experimental orchard owned by W. H. Hart, Poughkee psie

Plate 3

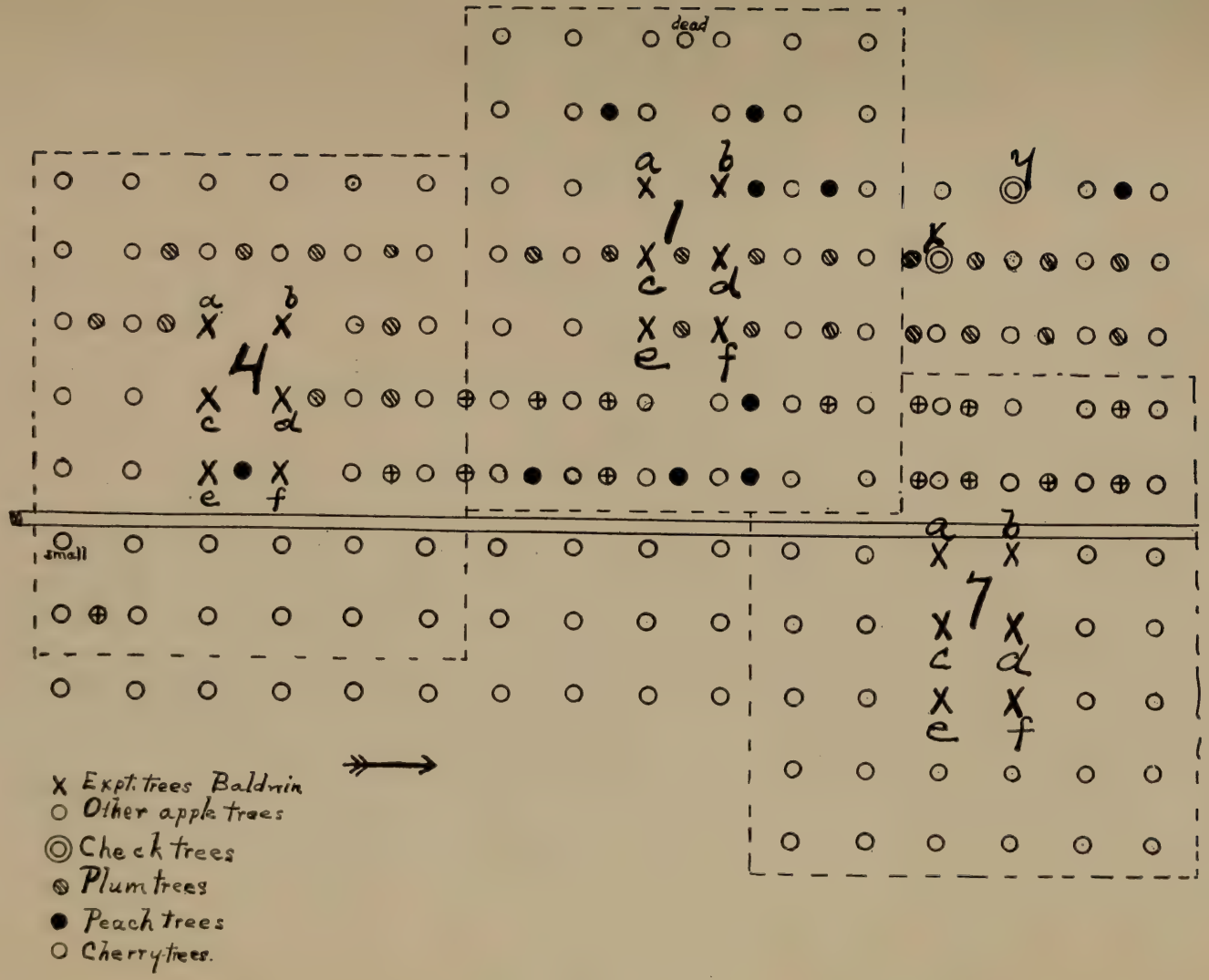


Experimental orchard, W. H. Hart, Poughkeepsie

PLATE 4

133

Plan of experimental orchard owned by Edward Van Alstyne, Kinderhook



Experimental orchard, Edward Van Alstyne, Kinderhook

PLATE 5

1 Experimental tree 1D
2 Experimental tree 2A
Poughkeepsie. Photo, October 1909

Plate 5

Experimental trees, 1 D (upper illustration), 2 A (lower illustration), Poughkeepsie

PLATE 6

137

1 Experimental tree 3B
2 Experimental tree 4B
Poughkeepsie. Photo, October 1909

Plate 6

Experimental trees, 3 B (upper illustration), 4 B (lower illustration), Poughkeepsie

PLATE 7

1 Experimental tree 5C
2 Experimental tree 6F
Poughkeepsie. Photo, October 1909

Plate 7

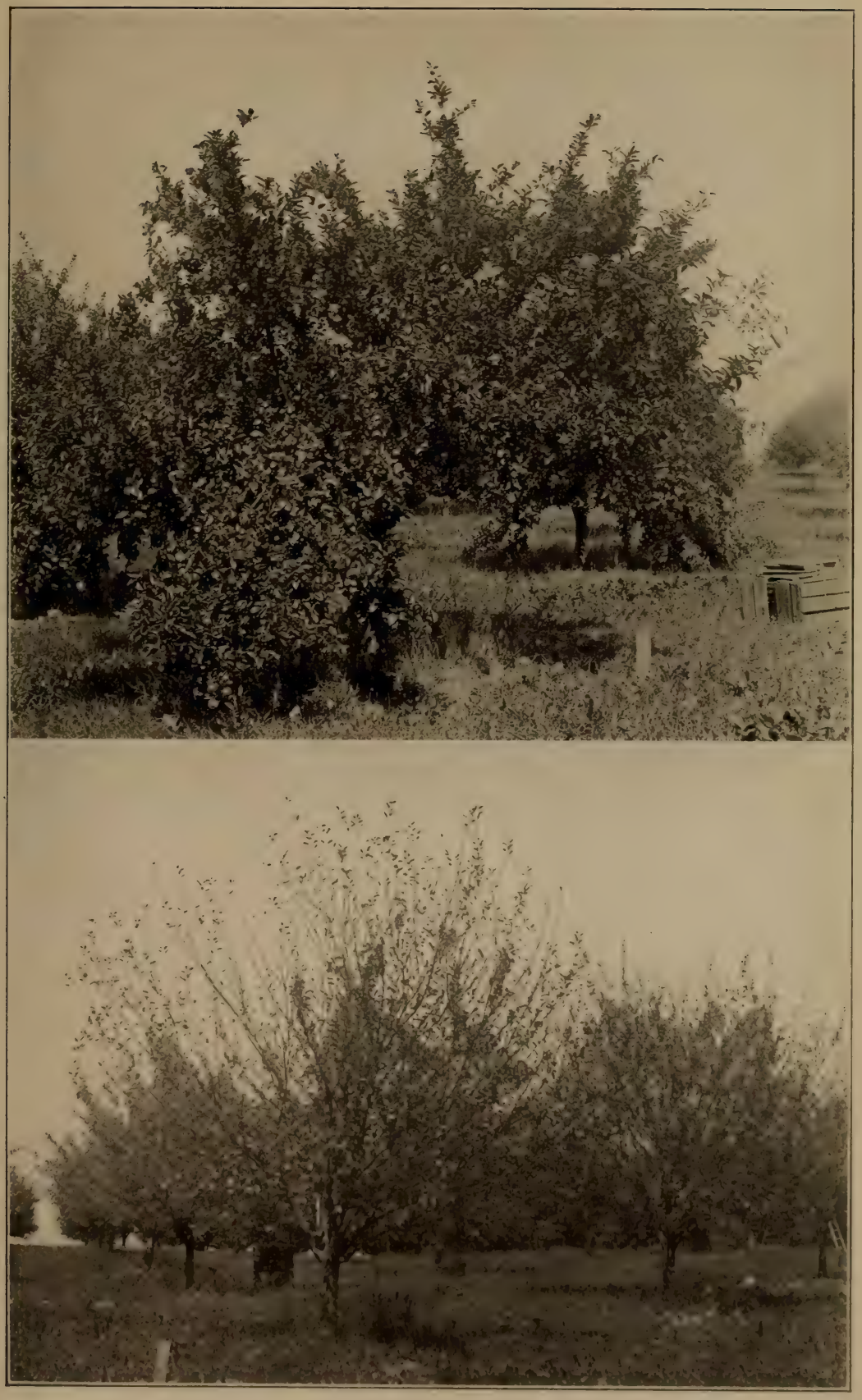
Experimental trees, 5 C (upper illustration), 6 F (lower illustration), Poughkeepsie

PLATE 8

141

1 Experimental tree X
2 Northern Spy in plot 3, note paucity of foliage
Poughkeepsie. Photo, October 1909

Plate 8



Experimental trees, X above, Northern Spy below

PLATE 9

143

1 Apples on experimental tree 1A. 2973 marketable fruit, 1893 small fruit, 104 wormy fruit

2 Apples on experimental tree 1D. 3739 marketable fruit, 4775 small fruit, 45 wormy fruit

3 Apples on experimental tree 1E. 1375 marketable fruit, 1013 small fruit, 72 wormy fruit

October picking, Poughkeepsie

Plate 9

1

2

3

Experimental trees, yield, Poughkeepsie

PLATE 10

145

1 Apples on experimental tree 2A. 1227 marketable fruit, 900 small fruit, 15 wormy fruit

2 Apples on experimental tree 2E. 2026 marketable fruit, 1571 small fruit, 25 wormy fruit

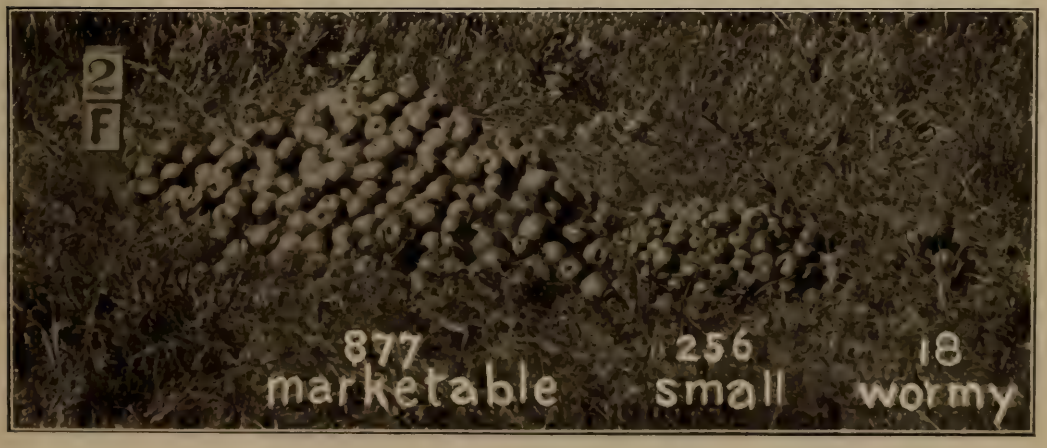
3 Apples on experimental tree 2F. 877 marketable fruit 256 small fruit, 18 wormy fruit

October picking, Poughkeepsie

Plate 10

1

2



3

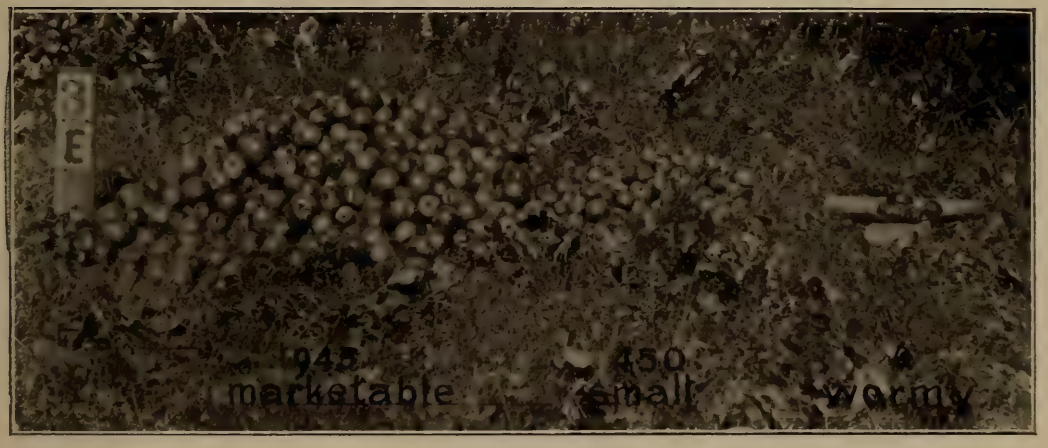
Experimental trees, yield, Poughkeepsie

PLATE 11

1 Apples on experimental tree 3B. 324 marketable fruit, 64 small fruit
4 wormy fruit
2 Apples on experimental tree 3E. 945 marketable fruit, 450 small fruit,
6 wormy fruit
3 Apples on experimental tree 3F. 1505 marketable fruit, 628 small fruit,
7 wormy fruit
October picking, Poughkeepsie

Plate 11

1



2

3

Experimental trees, yield, Poughkeepsie

PLATE 17

149

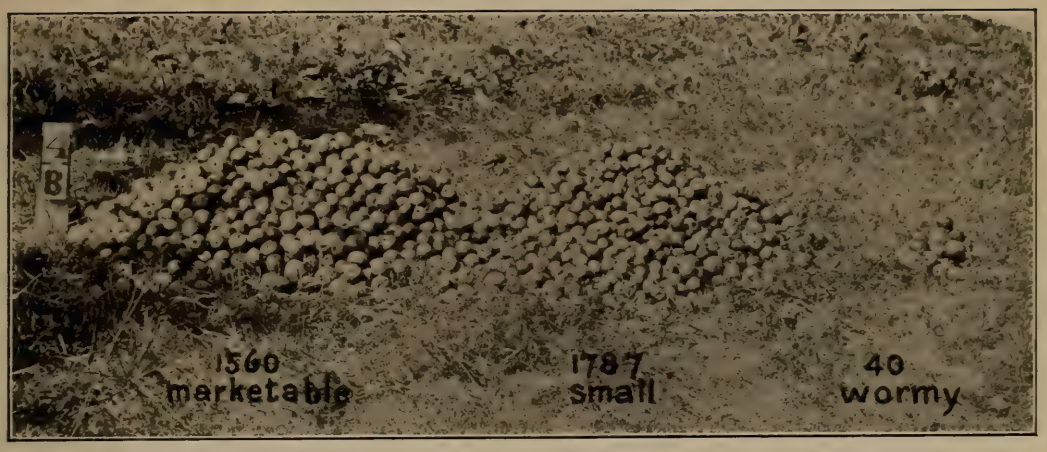
1 Apples on experimental tree 4B. 1560 marketable fruit, 1787 small fruit, 40 wormy fruit

2 Apples on experimental tree 4D. 3989 marketable fruit, 1984 small fruit, 40 wormy fruit

3 Apples on experimental tree 4F. 2244 marketable fruit, 2726 small fruit, 41 wormy fruit

October picking, Poughkeepsie

Plate 12



1

2

3

Experimental trees, yield, Poughkeepsie

PLATE 13

151

1 Apples on experimental tree 5A. 741 marketable fruit, 213 small fruit, 13 wormy fruit

2 Apples on experimental tree 5C. 1543 marketable fruit, 1773 small fruit, 21 wormy fruit

3 Apples on experimental tree 5E. 2271 marketable fruit, 1500 small fruit, 57 wormy fruit

October picking, Poughkeepsie

Plate 13

1

2

3

Experimental trees, yield, Poughkeepsie

PLATE 14

153

1 Apples on experimental tree 6D. 452 marketable fruit, 414 small fruit, 10 wormy fruit

2 Apples on experimental tree 6E. 2320 marketable fruit, 885 small fruit, 19 wormy fruit

3 Apples on experimental tree 6F. 417 marketable fruit, 253 small fruit, no wormy fruit

October picking, Poughkeepsie

Plate 14

1

2

3

Experimental trees, yield, Poughkeepsie

PLATE 15

155

1 Blossoms just ready to spray

2 Apples on check tree X. 923 marketable fruit, 973 small fruit, 493 wormy fruit

3 Apples on check tree Y. 225 marketable fruit, 186 small fruit, 166 wormy fruit

October picking, Poughkeepsie

1

2

3

1 Blossoms ready to spray,

2, 3 Experimental work, yield of check trees, Poughkeepsie

PLATE 16

157

1 Apples on experimental tree 1A. 2269 marketable fruit, 148 small fruit, 28 wormy fruit

2 Apples on experimental tree 1C. 1813 marketable fruit, 50 small fruit, 14 wormy fruit

3 Apples on experimental tree 1E. 3095 marketable fruit, 235 small fruit 34 wormy fruit

October picking, Kinderhook

Plate 16

1

2

3

Experimental trees, yield, Kinderhook

PLATE 17

159

1 Apples on experimental tree 4A. 905 marketable fruit, 200 small fruit, 17 wormy fruit

2 Apples on experimental tree 4C. 960 marketable fruit, 390 small fruit, 16 wormy fruit

3 Apples on experimental tree 4D. 1175 marketable fruit, 214 small fruit, 11 wormy fruit

Greenings, late September picking, Kinderhook

Plate 17

1

2

3

Experimental trees, yield, Kinderhook

PLATE 18

1 Apples on experimental tree 7B. 1498 marketable fruit, 87 small fruit 36 wormy fruit

2 Apples on experimental tree 7E. 2993 marketable fruit, 108 small fruit, 128 wormy fruit

3 Apples on experimental tree 7F. 3907 marketable fruit, 266 small fruit, 49 wormy fruit

October picking, Kinderhook

Plate 18

1

2

3

Experimental trees, yield, Kinderhook

PLATE 19

1 Blossoms after petals have fallen, showing in the sectioned blossom the space between the base of the stamens and the pistil

2 Apples on check tree X. 2938 marketable fruit, 116 small fruit, 401 wormy fruit

3 Apples on check tree Y. 1737 marketable fruit, 79 small fruit, 692 wormy fruit

October picking, Kinderhook

Plate 19

1

2

3

1 Blossom in section showing cavity at the base of the stamens

2, 3, Experimental work, yield of check trees, Kinderhook

PLATE 20

Upper figure, a decapitated Ben Davis in the orchard of Mr W. H. Hart at Poughkeepsie. This tree was cut back three or four years ago and is a striking illustration of the feasibility of this treatment. Photo, October 1909
Lower figure, a decapitated Baldwin in the same orchard

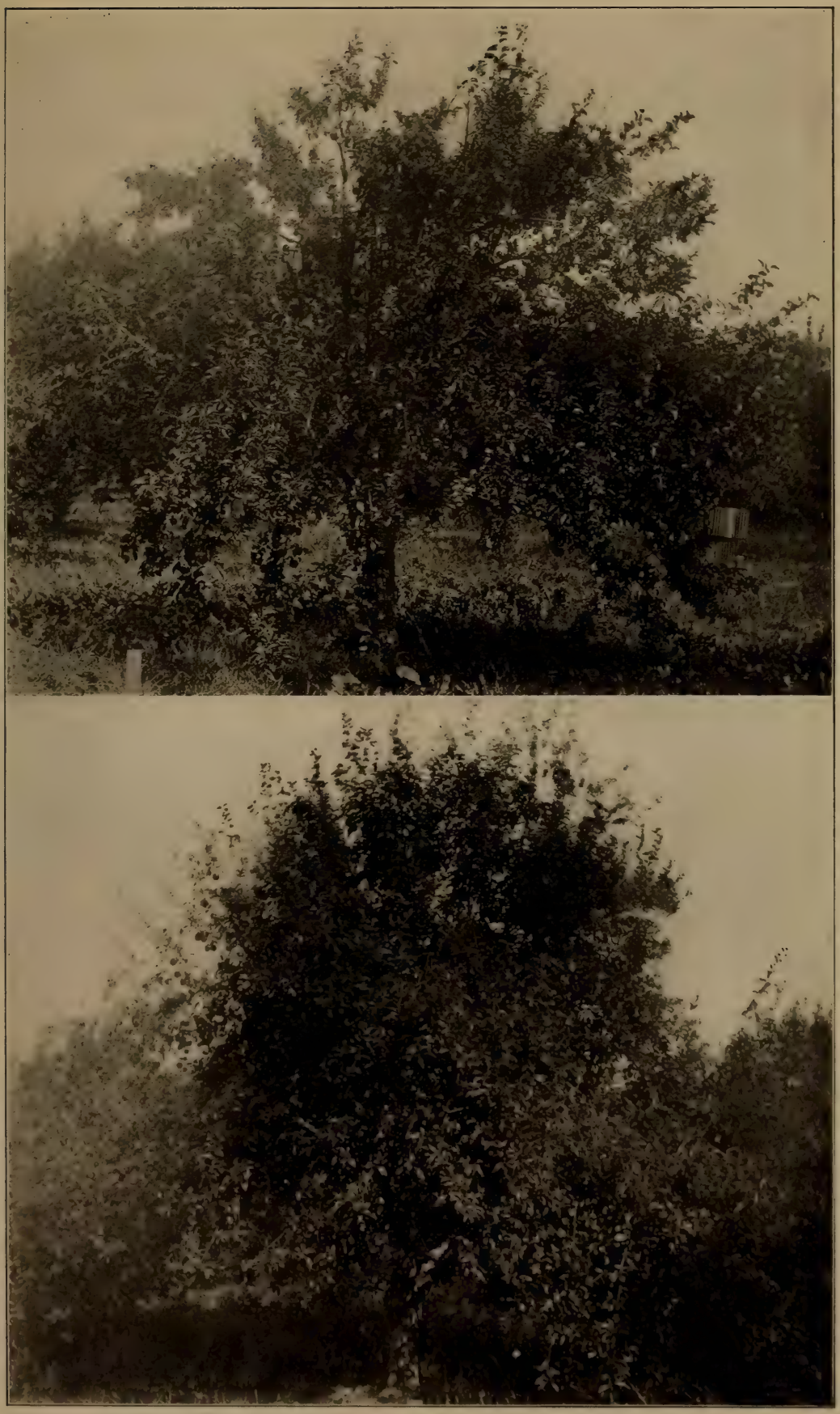
Trees in an old orchard, which has been infested by San José scale about 14 years

PLATE 21

Upper figure, a decapitated Sutton beauty in the old orchard of Mr W. H. Hart at Poughkeepsie. This tree has a remarkably fine showing of fruit. Photo, October 1909

Lower figure, a Ben Davis tree in the orchard of Mr W. H. Hart at Poughkeepsie. This tree has been infested with San José scale for 14 years and stands adjacent to the spot where the original infested tree stood. Photo, October 1909

Plate 21



Trees in an old orchard, which has been infested by San José scale about 14 years

PLATE 27

169

Characteristic nests of the brown tail moth, Euproctis chrysorrhoea Linn.

Plate 22

Characteristic nests of the brown tail moth

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New York State Education Department

New York State Museum

JOHN M. CLARKE, Director

PUBLICATIONS

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Museum annual reports 1847–date. *All in print to* 1894, 50c *a volume*, 75c *in cloth; 1894–date, sold in sets only; 75c each for octavo volumes; price of quarto volumes on application.*

These reports are made up of the reports of the Director, Geologist, Paleontologist, Botanist and Entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Director's annual reports 1904–date.

1904. 138p. 20c.
1905. 102p. 23pl. 30c.
1906. 186p. 41pl. 35c.
1907. 212p. 63pl. 50c.
1908. 234p. 39pl. map. 40c.
1909. 230p. 41pl. 2 maps, 4 charts, 45c.

These reports cover the reports of the State Geologist and of the State Paleontologist. Bound also with the museum reports of which they form a part.

Geologist's annual reports 1881–date. Rep'ts 1, 3–13, 17–date, 8vo; 2, 14–16, 4to.

In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899–1903. The two departments were reunited in 1904, and are now reported in the Director's report.

The annual reports of the original Natural History Survey, 1837–41, are out of print.

Reports 1–4, 1881–84, were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	17	$.75	21	$.40
14	.75	18	.75	22	.40
15, 2v	2	19	.40	23	.45
16	1	20	.50	[*See* Director's annual reports]	

Paleontologist's annual reports 1899–date.

See first note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Those for 1901–3 were issued as bulletins. In 1904 combined with the Director's report.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Reports 3–20 bound also with museum reports 40–46, 48–58 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3–4, 17 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	10	$.35	18 (Bul. 64)	$.20
2	.30	11	.25	19 (" 76)	.15
5	.25	12	25	20 (" 97)	.40
6	.15	13	*Free*	21 (" 104)	.25
7	.20	14 (Bul. 23)	.20	22 (" 110)	.25
8	.25	15 (" 31)	.15	23 (" 124)	.75
9	.25	16 (" 36)	.25	24 (" 134)	.35
				25 (" 141)	.35

Reports 2, 8–12 may also be obtained bound in cloth at 25c each in addition to the price given above

Botanist's annual reports 1867–date.

Bound also with museum reports 21–date of which they form a part; the first Botanist's report appeared in the 21st museum report and is numbered 21. Reports 21–24, 29, 31–41 were not published separately.

Separate reports for 1871–74, 1876, 1888–98 are out of print. Report for 1899 may be had for 20c; 1900 for 50c. Since 1901 these reports have been issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have also been published in volumes 1 and 3 of the 48th (1894) museum report and in volume 1 of the 49th (1895), 51st (1897), 52d (1898), 54th (1900), 55th (1901), in volume 4 of the 56th (1902), in volume 2 of the 57th (1903), in volume 4 of the 58th (1904), in volume 2 of the 59th (1905), 60th (1906), in volume 2 of the 61st (1907) and 62d (1908) reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum memoir 4.

Museum bulletins 1887–date. 8vo. *To advance subscribers, $2 a year or $1 a year for division (1) geology, economic geology, paleontology, mineralogy; 50c each for divisions (2) general zoology, archeology and miscellaneous, (3) botany, (4) entomology.*

Bulletins are grouped in the list on the following pages according to divisions.

The divisions to which bulletins belong are as follows:

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2	Botany	49	Paleontology	96	"
3	Economic Geology	50	Archeology	97	Entomology
4	Mineralogy	51	Zoology	98	Mineralogy
5	Entomology	52	Paleontology	99	Paleontology
6	"	53	Entomology	100	Economic Geology
7	Economic Geology	54	Botany	101	Paleontology
8	Botany	55	Archeology	102	Economic Geology
9	Zoology	56	Geology	103	Entomology
10	Economic Geology	57	Entomology	104	"
11	"	58	Mineralogy	105	Botany
12	"	59	Entomology	106	Geology
13	Entomology	60	Zoology	107	"
14	Geology	61	Economic Geology	108	Archeology
15	Economic Geology	62	Miscellaneous	109	Entomology
16	Archeology	63	Paleontology	110	"
17	Economic Geology	64	Entomology	111	Geology
18	Archeology	65	Paleontology	112	Economic Geology
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26	Entomology	73	Archeology	120	"
27	"	74	Entomology	121	Director's report for 1907
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32	Archeology	79	Entomology	126	Geology
33	Zoology	80	Paleontology	127	"
34	Paleontology	81	"	128	Paleontology
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42	Paleontology	89	Archeology	136	Entomology
43	Zoology	90	Paleontology	137	Geology
44	Economic Geology	91	Zoology	138	"
45	Paleontology	92	Paleontology	139	Botany
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47	"	94	Botany	141	Entomology

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19 Merrill, F. J. H. Guide to the Study of the Geological Collections of the New York State Museum. 164p. 119pl. map. Nov. 1898. *Out of print.*

21 Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sept. 1898. Free.

48 Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. 58p. il. 8pl. map. Dec. 1901. 25c.

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